

*An-Najah National University
Faculty of Graduate Studies*

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Optimal Nitrogen Fertilization Rates and Form for Cucumber in Plastic House

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Dedication

I Proudly and Gratefully Dedicate this
thesis to whom I love:

Father

Mother

Husband

Aunt (Rabeha Qanadillo)

Sisters

and Brothers

Acknowledgement

Thank God for everything and for helping me to complete this thesis. I would like to express my great gratitude and appreciation to my advisors Dr. Numan Mizyed and Dr. Hassan Abu Qaoud for their supervision, guidance and helpful suggestions throughout the research and for being patient and kind enough in reviewing this thesis. My thanks are extending to the members of the examination committee including Dr. Feras Sawalha and Dr. Zakaria Salawda for their patient reading and criticizing of this thesis. I sincerely thank the minister of agriculture Mr. Hikmat Zaid for allowing me to conduct soil and plant analyses in the laboratory of the ministry. I would like also to thank Dr. Hisham Sawafta for his valuable helps. Also, my thanks are provided to the technicians at Beta laboratory for soil and plant analysis especially Ms.Omia Hammad and their director Mr. Abdu-All-Rahman Altibawi.

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ABSTRACT

Optimal Nitrogen Fertilization and Form for Cucumber Plant in Plastic Houses

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A field experiment was carried out during 1999/2000 growing season to determine the relationship between nitrogen fertilization and cucumber yield, as well as to optimize the nitrogen quantity and form for cucumber growth under green house conditions. The research included two experiments. In the first experiment, two-cucumber cultivars were planted (Anas and Super) and subjected to three different combinations of four fertilizers (Ammonium sulfate, 20-20-20, KNO₃, Urea). In the second experiment different nitrogen levels (0, 16.43, 30.87, 46.58, and 62.30 Kg N/ dunum) were applied to summer cucumber cultivar IV36. The results of

the first experiment indicated that there were no significant differences in yield among different treatments for the first cultivar (Anas), compared to other cultivar (Super) which had significant differences in yield among treatments. The results indicated that the maximum yield (5528 Kg /du) in the second cultivar (Super) was obtained when (KNO₃, Urea, 20-20-20) were used. For plant length there were no significant difference among treatments for the two cultivars. Maximum leaf numbers (69.5) were obtained when (Ammonium sulfate, KNO₃, 20-20-20) were applied. For the second experiment the highest total yield was 9721 Kg/dunum (du), which was obtained when 30.87 Kg N/du were added. Maximum marketable yield was found when 27.2 Kg N/du was added. The yield at this amount was 7665 Kg/du. Maximum profit was obtained when 22.34 Kg/du of pure N fertilization were added. The nitrogen analysis for both fruits and leaves indicated that the nitrogen content in the fruits was significantly different among treatments, while in leaves there were no significant differences among treatments.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable crops grown under plastic houses in Palestine. The total estimated area of vegetables cultivated under plastic houses is 34299 dunums that consists about 19 % of the total vegetable area in Palestine. Agricultural statistics for the 1988-1996 period, indicated that the planted area and gross production for cucumbers under protected cultivation have increased in Palestine from 661 to 6654 dunums (du) and from 3938 to 51222 tons respectively (table 1.1). On the other hand, the open field area and gross production of cucumbers fluctuated from 7735 to 6001 dunums and 11989 to 8773 tons, respectively (table 1.2) (Ministry of Agriculture 1999). Fertilizer use in plastic houses is an important concept in crop production however, for an increase in fertilizer use without a corresponding yield benefit is a resource of waste. In the past, fertilizer recommendations aimed primarily at maximizing yield, but recently environmental pollution and cost concerns have become equally important.

The notion of applying fertilizers at rates suited to the changing nutrient needs of a crop is now a distinct possibility following major advances in understanding of plant nutrition and the availability of sophisticated nutrient delivery systems (Tisdale, *et al.*, 1984.). The bulk of fertilizers used now are manufactured by the chemical industry. These fertilizers

include nitrogen, phosphorous, and potassium which are the main nutrients applied to crops, other sources of nutrients that are applied to crops are organic manure (Wild, 1996).

Nitrogen (N) is an essential element for plant nutrition which is used at high rates by most plants, thus it is considered the most deficient nutrient in the soil. In intensive agriculture nitrogen is mainly applied to plant as an inorganic soluble fertilizer through the irrigation system (fertigation). The time of fertigation and the solubility of the fertilizer are two important factors that should be taken into consideration when one decides to fertigate. The time required for fertigation should be less than the time required for irrigation in order to make sure that the plant is not receiving fewer amounts than what needed. The solubility of the fertilizer should be high enough to guarantee that all the amount added would be dissolved in irrigation water (Tisdale, *et al.*, 1984). The high application rates of these products combined with high irrigation results in higher nitrogen loss through leaching. Leaching of nitrogen Compounds such as nitrates can move deeply into the soil to the groundwater resources (Mugaas, 1998).

1.1 Study Objectives: -

Therefore this research aims for achieving the following objectives:

- 1- To determine the relationship between nitrogen fertilization and cucumber yield.
- 2- To determine the optimum nitrogen quantity and form for cucumbers grown under greenhouse conditions.

Table 1.1: Area, Yield, and Production of Cucumber in Open Field in Palestine During 1988-1996

Year	Area Dunum	Yield Kg/dunum	Production Ton
1988	7735	1550	11989
1989	6936	1707	11840
1990	5680	1574	8940
1991	4678	1148	5370
1992	5564	1121	6237
1993	6566	1440	9455
1994	5443	1192	6488
1995	6724	1304	8768
1996	6001	1462	8773

Source: Ministry of Agriculture (MOA), Unpublished data, 1999.

**Table 1.2: Area, Yield, and Production of Cucumber in
Plastic houses in Palestine During 1988-1996**

Year	Area Dunum	Yield Kg/dunum	Production Ton
1988	661	5958	3938
1989	660	5941	3921
1990	2035	7515	15293
1991	4798	9904	47519
1992	5846	5996	35053
1993	5151	6783	34939
1994	4364	6598	28794
1995	5231	7335	38369
1996	6654	7698	51222

Source: Ministry of Agriculture (MOA), Unpublished data, 1999.

2-Literature Review:

2.1 Forms of Soil Nitrogen:

The total nitrogen content of soils ranges from less than 0.02% in subsoil to more than 2.5% in peats. Nitrogen concentration in the top 1 ft of most cultivated soils in the United States normally varies between 0.03 and 0.4%. The nitrogen present in soil can generally be classified as inorganic or organic. Ninety-five percent or more of the nitrogen in surface soils usually occurs in organic form. The inorganic forms of soil nitrogen include ammonium (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-), nitrous oxide (N_2O), nitric oxide (NO), and elemental nitrogen (N_2). The last form of nitrogen is inert except for its utilization by rhizobia and other nitrogen-fixing microorganisms. From the stand point of soil fertility, the NH_4^+ , NO_2^- , and NO_3^- forms are of greatest importance; N_2O and NO are also important in a negative way, for they represent forms of nitrogen that are lost through denitrification. The organic forms of soil nitrogen occur as consolidated amino acids or proteins, free amino acids, amino sugars, and other complex, generally unidentified compounds (Tisdale, *et al.*, 1990).

2.2 Forms of Nitrogen Absorbed by Plants:

Plants absorb most of their nitrogen in the NH_4^+ and NO_3^- forms, and uptake of this nutrient is complicated because plants usually have access to both forms. Nitrate is often the dominant source of nitrogen since it generally occurs in higher concentrations than NH_4^+ and it is free to move to the roots by mass flow and diffusion. Some NH_4^+ is always present and will influence plant growth and metabolism in ways that are not completely understood. Preference of plants for either NH_4^+ or NO_3^- is determined by age, type of plant, environment, and other factors. Cereals, corn, potatoes, sugar beets, pineapple, rice, and ryegrass use either form of nitrogen. Tomatoes, celery, bushbeans, squash, and tobacco grow best when provided with some NO_3^- . Some plant, such as blueberries, *chenopodium album*, and certain rice cultivars, cannot tolerate NO_3^- (Tisdale, *et al.*, 1990).

Nitrate (NO_3^-):

The rate of NO_3^- uptake is usually high and it occurs by active absorption. Nitrate uptake is favored by low-pH conditions. Its absorption can be competitively depressed by NH_4^+ . When plants are nourished with high

level of NO_3^- , there is an increase in organic anion synthesis within the plant coupled with a corresponding increase in the accumulation of inorganic cations (Ca^{+2} , Mg^{+2} , and K^+). The growth medium will become alkaline and some HCO_3^- can be released from the roots in exchange for excess organic anion formation (Tisdale, *et al.*, 1990).

Ammonium (NH_4^+):

Ammonium is the preferred nitrogen source since energy will be saved when it is used instead of NO_3^- for synthesis of protein. Also, NH_4^+ is less subject to losses from soil by leaching and denitrification. Plant uptake of NH_4^+ proceeds best at neutral pH values and is depressed by increasing acidity. Absorption of NH_4^+ by roots reduces the concentration of inorganic cations such as calcium, magnesium, and potassium in plant tissues while raising level of inorganic anion, including phosphorous, sulfur and chloride (Tisdale, *et al.*, 1990).

Ammonium and Nitrate Combinations:

Growth of plants is often improved when the plants are nourished with both NO_3^- and NH_4^+ rather than with either NH_4^+ or NO_3^- singly (Tisdale, *et al.*, 1990).

2.3 Soil Nitrogen Cycle:

We live in an ocean of nitrogen, but the supply of food for human being and other animals is more limited by nitrogen than any other nutrient. The atmosphere is 79 percent nitrogen (by volume) as inert N_2 gas that resists reacting with other elements to create a form of nitrogen that most plant can use. (Foth, 1990).

The nitrogen cycle consists of a sequence of biochemical changes where nitrogen is used by living organisms, transformed upon death and the decomposition of the organisms, and converted ultimately to its original state of oxidation. The major segments of the soil nitrogen cycle are shown as five steps or processes in (appendix c). The reservoir of nitrogen for plant use is essentially that in the atmosphere, N_2 . There is virtually an inexhaustible supply of nitrogen in the atmosphere, since (at sea level) there are about 77.350 metric tons of N_2 in the air over one hectare (34.500tons/acre). It takes about a million years for the nitrogen in the atmosphere to move through one cycle. The N_2 is characterized by both an extremely strong triple bonding between the two nitrogen atoms and a great resistance to react with other elements. The processes of converting N_2 into forms that vascular plants can use is termed as nitrogen fixation, the other major steps in the soil nitrogen cycle are: mineralization, nitrification, immobilization, and denitrification. (Foth, 1990). (Figure 2.1).

Figure (2.1) The Nitrogen Cycle. Best Management Practices for Nitrogen Fertilization. www.Colostate.edu/Depts/CoopExt/

Nitrogen Fixation:

The primary pathways by which nitrogen is converted to forms usable by higher plants are: Fixation by rhizobia and other microorganisms that live symbiotically on the roots of legumes and certain nonleguminous plants, Fixation by Free-living soil microorganisms, Fixation as one of the oxides of nitrogen by atmospheric electrical discharges, and Fixation as ammonia, NO_3 , or N_2 by any of the various industrial processes for the manufacture of synthetic nitrogen fertilizers (Tisdale, *et al.*, 1985).

Biological nitrogen fixation is a reduction reaction requiring energy that is supplied by adenosine triphosphate (ATP). Nitrogen fixing microorganisms contain the enzyme nitrogenase that combines with a nitrogen molecule, N_2 . Pyruvic acid is the hydrogen donor, and fixation occurs in a series of steps that reduces the N_2 to NH_3 . Molybdenum is a part of nitrogenase and essential for biological nitrogen fixation (Foth, 1978). Symbiotic and symbiotic biological systems fix an estimated 100-175 million metric ton of nitrogen annually. ([http://www.nap.edu/reading room/books/bnf/chapter1.html](http://www.nap.edu/reading_room/books/bnf/chapter1.html)).

Non-biological nitrogen fixation occurs through the effects of lightning, and in industry primarily by the Haber-Bosch process, which requires high levels of fossil fuel. World wide, lightning may fix 10 million metric tons of nitrogen a year, a value that probably has not changed over time. Industrial fixation for fertilizer nitrogen has increased from 8 million tons

in 1950 to 305 million tons in 1989 (<http://www.nap.edu/readingroom/books/bnf/chapter1.html>).

Some of NH_4^+ added to the soil might be attracted by the negative clay lattice resulting into its fixation by clays with an expanding lattice. The mechanism of NH_4^+ fixation is similar to that of K^+ fixation. It comes about by a replacement of NH_4^+ for interlayer cations in the expanded lattices of clay minerals. The fixed ammonium can be replaced by cations that expand the lattice (Ca^{+2} , Mg^{+2} , Na^+ , H^+) but not by those that contract (K^+ , Rb^+ , Cs^+). Certain clay minerals, particularly vermiculite and illite, are chiefly responsible for the fixation of NH_4^+ (Tisdale, *et al.*, 1990).

Mineralization:

Mineralization is the conversion of an element from an organic form to an inorganic state as a result of microbial decomposition. Mineralization is also called ammonification because the end product is ammonia. Some NH_3 produced at the very surface of the soil escape by volatilization, especially when soil pH is 8 or more. If the mineralization rate is 2 to 3 percent per year, there will be approximately 20 to 30 pounds of nitrogen mineralized each year for each percent of organic matter in the surface soil.

Organic matter also exists below the surface plow layer, and this organic matter is slowly mineralized. It is important to realize that the nitrogen-supplying power of a soil is intimately related to the organic matter content and mineralization rate. Sandy soils are low in organic matter, therefore they are poor in their ability to supply available nitrogen. Organic soils that have been drained, have maximum potential for supplying nitrogen to plants, since these soils are rich in organic matter (Foth,1978).

Mineralization is brought about by a large number of heterotrophic microorganisms that derive carbon compounds and energy from soil organic matter. Because of the wide range of microorganisms involved, the process can take place in most soils even those which are too acidic, too alkaline, too dry or too wet for. However, optimum conditions for ammonification are conditions suitable for abundance of microorganisms and their maximum activity, which include good aeration, moisture content around field capacity and neutral pH (Wild, 1996).

The mineralization of organic nitrogen compounds takes place in essentially three step-by step reactions:

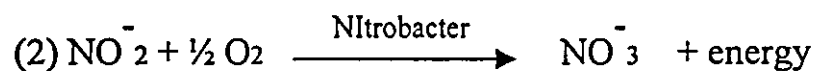
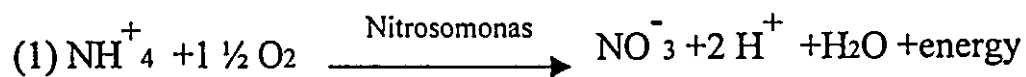
1-Aminization 2- Ammonification 3- and Nitrification (Tisdale, *et al.*, 1990).

Nitrification:

Nitrification is the biological oxidation of ammonium to nitrite and nitrate.

Or a biological induced increase in the Oxidation State of nitrogen.

If roots or microorganisms do not absorb ammonium or if ammonium is not fixed in clay, ammonium is commonly oxidized to nitrate (Foth, 1978). Nitrification occurs most rapidly in moist soil (water potential of -10kPa to -13kPa) which is aerobic, has a pH of 5.5 to 8 and a temperature of $25-30^\circ\text{C}$. It occurs more slowly in soils outside these optimum conditions (Wild, 1996). This process, nitrification, is a two step process with nitrite as the intermediate product. Specific autotrophic bacteria are involved. The reactions and organisms are as follows.



Nitrification results in the production of hydrogen ions and is a potential for increasing soil acidity (Foth, 1978).

Factors influencing the activity of the nitrifying bacteria have a pronounced effect on the amount of nitrates produced and consequently on the utilization of nitrogen by plants. Factors affecting the nitrification pattern in soil are:

1- Supply of Ammonium Ion: because of substrate for the nitrifying bacteria is the ammonium ion, a supply of this ion is the first requirement for nitrification (Tisdale, *et al.*, 1990).

- 2- Population of Nitrifying Organisms: the presence of different – sized populations of nitrifiers would probably result in differences in the lag time between the addition of ammonium source and the building of nitrate nitrogen in the soil (Tisdale, *et al.*, 1990).
- 3- Soil Reaction: the range of reaction over which nitrification takes place has generally been given as pH 5.5 to about 10.0, with the optimum around 8.5 (Tisdale, *et al.*, 1990).
- 4- Soil Aeration: the nitrobacteria, are obligate autotrophic aerobes. They will not produce nitrates in the absence of molecular oxygen (Tisdale, *et al.*, 1990).
- 5- Soil Moisture: nitrobacterial activity is sensitive to soil moisture. The rates of nitrogen mineralization (NH_4^+ and NO_3^-) are generally highest at soil water contents equivalent to low matric suctions of about 1/3 bar. Nitrogen mineralization tends to be impeded in wet soils with moisture contents exceeding 1/3 bar or field capacity. Between 15 bars and air dryness, nitrogen mineralization continues to decline gradually (Tisdale, *et al.*, 1990).
- 6- Temperature: change in the mineralization rate is associated with a shift of 10°C within the temperature range 5 to 35°C . Below 5 and above

40 °C the rate of nitrogen mineralization usually drops off, with the optimum commonly lying between 30 and 35 °C. It should be noted, however, that slow formation of nitrate has been detected down almost to the freezing point of water (Tisdale, *et al.*, 1990).

Nitrate supplied in commercial fertilizer or produced by nitrification of ammonium is subjected to leaching. The NO_3^- form of nitrogen is completely mobile and within limits moves largely with the soil water. Under conditions of excessive precipitation or irrigation it is leached out of the upper horizons of the soil. During extremely dry weather and when capillary movement of water is possible there is an upward movement with the upward movement of water. Under such conditions nitrates will accumulate in the upper horizons of the soil or even on the soil surface (Tisdale, *et al.*, 1990).

Immobilization:

Immobilization is the conversion of an element from the inorganic to the organic form in microbial tissues or in plant tissues. Both ammonium and nitrate are available forms of nitrogen for roots and microorganisms, and their use results in the conversion of mineral forms of nitrogen into organic form. Immobilized nitrogen is "safe" in the soil and subject to repeated cycling through the nitrogen sub cycle in the soil, which involves

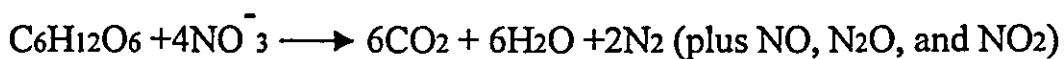
mineralization, nitrification, and immobilization. Below the root zone or zone of biological activity nitrate will not be immobilized or denitrified (Foth, 1978).

Immobilization of nitrogen is the reverse of mineralization and it occurs when large quantities of low-nitrogen crop residues such as cereal crop straw being decomposing in soil. The high amount of carbohydrate in such residues cause the population of soil microflora to build up quickly. As new cells are formed, nitrogen and other essential elements are used to build protoplasm. Almost invariably this leads to a decrease in the levels of inorganic nitrogen for crops. A shortage of nitrogen can be avoided in such situations by supplying enough fertilizer nitrogen to compensate for immobilization and to meet the crop requirements (Tisdale, *et al.*, 1990).

Denitrification:

Denitrification is the reduction of nitrate (NO_3^-) or nitrite (NO_2^-) to gaseous nitrogen (N_2) and other oxides of nitrogen by microbial activity (biological denitrification), and to the chemical reduction of NO_2 and other unstable nitrogen compounds (Chemical denitrification). Biological denitrification is often called dissimilatory denitrification to distinguish it from assimilatory denitrification in which microorganisms assimilate and reduce nitrate as a first step in protein synthesis. Denitrification requires the presence of nitrate, metabolizable carbon compounds and the almost

complete absence of oxygen at the site of reduction. The rate of denitrification increases with temperature and is highest at a soil pH between 6 and 8 (Wild, 1996). Just as it is natural for nitrogen to be added to soil by fixation, it is natural for nitrogen to be lost from soils by denitrification. In a climax forest or grassland where the organic matter content of the soil remains constant from a year to another and the amount of nitrogen cycling in the soil remains about constant from a year to another, the addition of nitrogen by fixation approaches the losses of nitrogen from the soil by denitrification. Thus, denitrification is one of the most significant processes in the nitrogen cycle and accounts for significant losses of nitrogen from soils. Denitrification is carried out by facultative anaerobic organisms that use nitrate in place of oxygen in respiration, as follows.



Denitrification, is an important process that can be used to help prevent excess nitrates from building up in the groundwater of irrigated valleys where large amounts of nitrogen fertilizer are used (Foth, 1978).

Factors Affecting Denitrification:

- 1- Decomposable Organic Matter: the amount of readily decomposable organic matter in soil is a critical determinant in the rate of denitrification. Drying and air storage of soils greatly increases their

ability to denitrify nitrate under anaerobic conditions (Tisdale, *et al.*, 1990).

2- Soil Water Content: water logging of soil results in rapid denitrification by impeding the diffusion of O₂ to sites of microbiological activity. Saturation of soil with water during snowmelt in the spring is now suspected of causing major denitrification losses of nitrogen in the intermountain states such as Utah. The duration of snow cover on fields and when the melting took place are two factors that seem to affect denitrification associated with spring thawing (Tisdale, *et al.*, 1990).

3- Aeration: aeration or oxygen availability affects denitrification in two apparently contrasting ways. Formation of NO₃⁻ and NO₂⁻, which are the forms of nitrogen denitrified, is dependent on an ample supply of O₂. Their denitrification proceeds only when the O₂ supply is too low to meet microbiological requirements. The denitrification process can operate in seemingly well-aerated soil, presumably in anaerobic micro sites where biological O₂ demand exceeds the supply. Nitrogen losses as a result of denitrification at atmospheric oxygen content of 7.0 to 8.5% were only 20% of the loss observed when the oxygen content was 4.0 to 5.7%. When the oxygen was reduced from 1.0 to 1.6%, losses of nitrogen of the 7 to 8.5% level of oxygen were only 4% of those sustained at the lowest level (1.0 to 1.6%) (Tisdale, *et al.*, 1990).

4- Soil reaction: soil acidity can have a marked influence on the denitrification process since many of the bacteria responsible for this biochemical reduction are sensitive to low pH values. The rate of denitrification is greatly influenced by soil pH, being very slow in acid soils (pH 3.6 to 4.8) and very rapid in soils high pH (8.0 to 8.6) (Tisdale, *et al.*, 1990).

5- Temperature: the process of denitrification is very sensitive to soil temperature and its rate increases rapidly in the 2 °C to 25 °C range. Denitrification will proceed at slightly higher rates when the temperature is increased in the range 25 to 60 °C. It is inhibited by temperatures greater than 60 °C (Tisdale, *et al.*, 1990).

6- Nitrate level: high nitrate concentrations increase the rate of denitrification and exert a strong influence on the ratio of nitrous oxide (N₂O) to elemental nitrogen (N₂) in the gases released from soil by denitrification (Tisdale, *et al.*, 1990).

2.4. Gaseous Losses of Nitrogen:

There are losses of nitrogen from soil in ways other than leaching and crop removal. Gaseous losses occur primarily as nitrous oxide (N₂O) and dinitrogen (N₂) during reductive (denitrification) and oxidative

(nitrification) processes. Other mechanisms leading to gaseous losses of nitrogen from soil include:

- 1- Chemical decomposition of nitrite under aerobic conditions to form N_2 , NO plus NO_2 , and small quantities of N_2O .
 - 2- Non biological volatilization of free ammonia.
- (Tisdale, *et al.*, 1985).

2.5. Factors Favoring Nitrite Accumulation:

Nitrite does not usually accumulate in soil, but when it does occur in significant amount it can adversely affect plants and microorganisms. Building of toxic levels of nitrite is generally caused by two factors, alkalinity and high ammonium level. At pH values of 7.5 to 8.0, the rate of nitrite production exceeds that of nitrate production, but at neutral pH values the potential for converting nitrite to nitrate exceeds that for converting ammonia to nitrite (Tisdale, *et al.*, 1990).

2.6. Nitrogen and soil relationship:

Fixation and denitrification are approximately equal and responsible for a quasiequilibrium between the nitrogen in the atmosphere and the nitrogen in the lands oceans (Foth, 1978).

Leaching potential of a given site depends upon soil properties, management, irrigation, and climatic factors. Depth to groundwater and the overlying geologic material determine the contamination potential of the

aquifer. Leaching hazard can be ranked as severe, moderate, or slight by simultaneously considering soil characteristics, irrigation method, and aquifer vulnerability. Leaching is a major problem on coarse-textured soils, while denitrification is the primary pathway on poorly drained clay soils (Cardon and Mortvedt, 1999).

Inorganic fertilizers such as Ammonium Nitrate and Ammonium Sulfate are all water-soluble and quick-release N sources. On sandy soils, high application rates of these products combined with high irrigation or rainfall amounts may result in higher N loss due to leaching. Leaching is the movement of water and possibly nutrients down into and potentially beyond plant root zone. Once beyond the root zone, nitrates can continue moving through the soil and may find their way into ground water sources (Mugaas, 1998)

On highly leachable soils such as sands and sandy loams, the recommended N application rates may result in excessive loss of nitrate N due to leaching. Watering practices that move water beyond the root zone may increase potential nitrate- N leaching. Daily irrigation during cool, moist periods increase the potential for leaching. Adding enough water to compensate for that removed by plant uptake and evaporation minimizes potential N pollution problems from leaching (Mugaas, 1998).

There are several significant environmental reasons to seek alternatives to chemically fix nitrogen fertilizers: it affects the balance of the global

nitrogen cycle, pollutes ground water, increases the risk of chemical spills and increases atmospheric nitrous oxide (N_2O), a potent “greenhouse” gas. Fertilizer nitrogen is used inefficiently by crops. Up to 50% becomes part of the current crops; of the 50%, or more, some is stored in soil organic matter, where it becomes available to subsequent crops, some is converted back to atmospheric nitrogen through the denitrification, and the remaining is leached and potentially contaminates the groundwater as nitrate (NO_3^-).

Nitrate pollution of groundwater is a significant environmental problem of high-production-crop agriculture. (Biological nitrogen fixation. <http://www.nap.edu/reading-room/books/bnf/chapter1.html>).

The concentration of nitrate in drainage water depends on the volume of through-drainage and the amount of nitrate that is available to be leached. Loss of nitrate is undesirable because: it represents an economic loss to the farmers, it is considered to be a health hazard in drinking water, and finally it may cause eutrophication (Samuel, 1984).

A primary consideration in using N fertilizers responsibility is to match the site conditions and the desired maintenance program with the proper N fertilizer sources (Mugaas, 1998). Thus, to improve yield quantity and quality, a proper supply of water and fertilizers should be attend through out the growing season (AL-Deek, 1994).

Applications of animal manure to soil result in nitrification of applied NH_4^+ -N and eventual loss of applied N through leaching and/or denitrification processes. In theory, one way to reduce the leaching and / or denitrification losses through the use of a nitrification inhibitor. Nitrapyrin is effective in inhibiting nitrification in manure-treated soil. Addition of this inhibitor reduces N losses following manure application. (McCormick R.A. *et al.*, 1983).

An important environmental issue is ground water-N pollution. Addressing this issue requires understanding the impact of farm management practices on nitrate leaching. Results from studying the effects of crop choice and crop rotation pattern, fertilizer management and tillage practice on leaching suggest that relative reduction in groundwater N leached is markedly greater at higher rates of fertilizer application than at lower (below the maximum economic rate of N fertilization) rates. Although tillage may not dramatically affect N leaching, other farm management practices such as crop type and crop rotation choice, along with the carry-over effects of these management activities on mineralization of soil organic matter, may have a significant effect on N leaching from the root zone. (Emmanuel K. *et al.*, 1997).

Ammonia volatilization is a major cause of nitrogen loss in calcareous soils. Since most Jordanian soils are highly calcareous, NH_3 volatilization

affects N fertilizer efficiency and crop production. Volatilization of NH_3 from ammonium sulfate and Urea in soils from Hisban region, Al-Jerm (Jordan valley), and Azraq region were studied in the laboratory. Results of this study showed that the volatile N loss increased with time proportional to the application rate. Urea fertilizer efficiency is predicted to be low in Al-Jerm soil where the highest N volatilization occurred, also in Azraq saline soil where the urea hydrolysis did not occur. Consequently, the utilization of urea fertilizer in this soil was found to be extremely low (El-khattari and Kharabsheh 1983).

2.7 Nitrogen plant relationship:

2.7.1. Effect of Nitrogen on Growth:

Nitrogen is the key element in plant growth. It is a constituent of plant proteins, chlorophyll, nucleic acids, and other plant substances (Donahue et al., 1983). Nitrogen is also a part of chlorophyll, and nitrogen deficient plants have light – green or yellow leaves. Nitrogen- deficient plants are stunted, producing low crop yields. The yellowish color of lawns in the growing season is usually an indication of nitrogen deficiency. Many plants develop distinct nitrogen-deficiency symptoms, including yellow midribs of the lower leaves of corn (maize) plants. An excess of nitrogen causes rapid vegetative growth and dark-green leaves. The vegetation is succulent

and has reduced resistance to injury from insects, disease, and frost. (Foth, 1990).

Solution culture studies showed that vegetative growth for cucumber was best with 100% $\text{NO}_3\text{-N}$ (Shou-SenYan *et al.*, 1996). When $\text{NH}_4\text{-N}$ was 25% or 50% of the total N, reproductive growth was promoted: the height of the first female flower was decreased, and the percentage of female flowers and the yield per plant were increased compared with plants receiving 100 % $\text{NO}_3\text{-N}$. (Shou-SenYan *et al.*, 1996)

2.7.2. Effect of Nitrogen on Yield:

Ruiz and Ronero, 1998 found that nitrogen applications of $10\text{--}20\text{ g m}^{-2}$ to cucumbers (*Cucumis sativus* L. cv. Bunex) were best for human consumption and economic profit according to the World health organization (WHO). These N application rates encouraged a good relationship between commercial yield and fruit quality. Higher rates of 40 g m^{-2} resulted in low commercial production and low quality as the fruit had the greatest NO_3^- . Lower applications of $2.5\text{--}5\text{ g m}^{-2}$ rates produced poor yield and poor commercial quality (Ruiz & Romero, 1998).

Results from McCollum and Miller, 1971 showed that cucumber plant sets fruit even under severe nutritional stress, well-fertilized plants made more

vegetative growth. The maximum rate of growth and nutrient accumulation occurred about 50 days after seeding (McCollum and Miller, 1971).

Fertilization of a certain crop must be reasoned according to crop demand and the soil nutrient availability for a definite production objective, which may be different from maximum yield and have to be combined with other aims such as degradation of resources and minimizing pollution of the environment (Al-Deek, 1994). Managing the amount, form, placement, and timing of N application is the most practical and acceptable approach to minimizing ground and surface water contamination resulting from fertilizer use (Cardon G. E. and Mortvedt J.J., 1999).

Ruiz. And Romero (1999) reported that the intermediate N rates (10 to 20 g/m^2) gave higher utilization of NO_3^- in the leaves of cucumber plants (highest NR activities) than both inadequate (5 g/m^2) and excessive (40 g/m^2) treatments. Excessive treatments (40 g/m^2) appear to result in excessive foliar assimilation of NO_3^- , thereby increasing amino acids and proteins and inhibiting or reducing NR activity. Moderate treatments (10-20 g/m^2) strengthened the translocation of organic nitrogenous compounds (amino acids) towards the fruit, which enhanced the commercial yield.

Accumulation of Nitrates is affected by the type of cucumber hybrid. Among the numerous hybrids studied, the F1 hybrid Estafeta (honeybee

pollinated) and 2616 (parthenocarpic) were noted for a much lower accumulation of nitrates than other hybrids and this was partly attributed to a shallower root system in Estafeta. I NFT, fruit yield exceeded 25Kg/m^2 with a nitrate content of 150-220 mg/Kg. (Apostol-PA; *et al.*, 1992).

The nitrogen fertilization 19 Kg N/du reflected the most suitable effect on the cucumber productivity (El-sharkawy, A.M. *et al.*, 1991). The highest yield and best fruit quality (fruit size) as well as plant vitality (chlorophyll content) were obtained in plant population density at distance of 40 cm and fertilized with 19 Kg N/du. (El-sharkawy, A.M. *et al.*, 1991).

The greater yield at greater N application rates confirm that commercial yield depends on the N application rate (Nattson et al, 1991; Lopez-Cantarero et al, 1997). Nitrogen form or concentration did not affect inflorescence diameter and peduncle length. (Abu-Zahra *et al.*, 1997).

2.7.3. Nitrogen and Other Element Relationship:

High nitrogen concentration (200 mg/L) in nutrient solution induced yield reduction of greenhouse cucumber in soilless culture systems. One reason for that was deficiency of calcium in the youngest leaves during the fruit growing period in spite of sufficient calcium supply (200 mg/L). In these leaves calcium deficiency symptoms have been observed too (1.5% Ca in dry matter of leaves). At high nitrogen supply the plants took up less calcium, as their damaged roots were not able to take up calcium. This was

due to a low root growth, and the more nitrogen was supplied the more roots died during the fruit yield period. (Schacht H. *et al.*, 1992).

Ward (1967) stated that in cucumber plant N and K were decreased in percentage as the plant aged. Ca and Mg increased, and P remained relatively constant. Potassium was found to be the most important element to affect quality. He found that absorption of this element extended to the end of growth. He also found that N absorption continued till the end of growth, but at a somewhat lower level than that of K.

2.7.4. Effect of Nitrogen on Quality:

The effect of N (NO_3NH_4 at 5,10,20 or g/m^2), P (H_3PO_4 at 7 or 14 gm/m^2) and K (K_2SO_4 at 20 or 40 g/m^2) on the content of chlorophyll-a (Chl-a), chlorophyll-b (Chl-b) carotene's and lycopene in leaves of cucumbers (cv. Brunex), grown under controlled conditions, were investigated. Leaves were sampled every 15 days. The concentrations of Chl-, Chl-b and carotenes increased with increasing rate of N, except at the highest rate N had little effect on lycopene conten. It was concluded that N affected the content of pigments, especially photosynthetic pigments, and that high doses of P acted negatively on most of the pigments studied (Lamrani-Z *et al.*, 1995).

Cucumber cv. Pepinex and tomato cv. Dombo plants were grown under greenhouse conditions. The highest foliar glucose, fructose, sucrose and

starch concentrations in cucumber were generally obtained with 30 g N/m² (Valenzuela *et al.*, 1989).

Fruit weight was increased by N fertilizer rate, but fruit production was not influenced significantly by rate of N fertilizer. Highest fruit quality was achieved with the lowest N fertilizer rate. Fruit quality was negatively related to N in leaves and fruit peel and cortex as well as leaf boron (B), fruit peel copper (Cu), magnesium (Mg) and fruit cortex Mg, and manganese (Mn) for both interstems. Lower rates of N fertilizer were related to lower concentrations of leaf and fruit N. (Raese, J.T and Drake, S.R.1997)

When plant were provided with 100 ppm of N as a combination of nitrate-N and ammonium-N (25/75,50/50,or 75/25) fresh and dry weight per plant were increased more rapidly.(Schrader *et al.*, 1972)

Nitrogen is known to promote cell elongation and vegetative growth.(Dubetz and Boli 1975) .

The effect of the source of N on individual amino acids contents (measured in leaves) differed between cucumber and tomato. In tomato, the concentrations of short – chain organic acids were 2-3 times higher in plants supplied with NO₃ than in those grown with NH₄⁺ NO₃. In cucumber malic acid concentration increased as a function of the nutrient solution salinity. (Martinez *et al.*, 1994).

2.7.5. Pre Plant Fertilization:

Different pre plant and side dress N fertilizer rates from NH_4NO_3 or urea were applied to pickling cucumbers (*Cucumis sativus* L.) grown for once-over harvest to determine the effect of N rate, source and time of application on cucumber yield, sex expression, and fruit quality. Nitrogen pre plant rates of 67 or 134 Kg/ha resulted in greater yields than no N pre plant fertilizer. Pre plant rates of 201 or 268 Kg/ha gave lower yield. The pre plant source of N, NH_4NO_3 or urea had no effect on yield. Side dress N as NH_4NO_3 or urea generally did not influence yields when pre plant N was used at rates of 67 or 134 Kg/ha. The addition of pre plant N fertilizer up to 134 Kg/ha resulted in a slightly greater number of pistillate flowers per plant. The percentages of off-shape fruit were highest for the rate (268 Kg/ha) of pre plant N. Fruit quality evaluation (shape and color) and length: diameter ratios were generally not influenced by pre plant N fertilizer (Cantliffe, 1977).

Four field experiments were conducted during a 2-year period to determine the influence of supplemental irrigation, in-row spacing and pre planting N-P-K rates on yield, fruit length, leaf size and leaf contents of N,P and K of cucumbers (cv. Sprint 440). Yield increased linearly with the increase in pre planting N-P-K rates (0-0-0 to 204-44-88 Ib/acre) in 1987. (Hanna-HY and Adams-AJ 1991).

3- MATERIALS and METHODS

3.1 Experiment Domain:

This study was conducted at An-Najah National University- Faculty of Agriculture at Tulkarem campus, during the 1999/ 2000 seasons. Two experiments were conducted, the first one was carried out during May to August 1999, and the second was done during March to May 2000. The two experiments were conducted under plastic house conditions.

Tulkarem is located in the northwestern part of the West Bank. It lies at about 40 -500 m above sea level and is entirely within the fertile semi-coastal zone of the West Bank. (Arij, 1996). The climate of Tulkarem is of a Mediterranean type with moderate hot-dry summers and warm wet winters. (Arij, 1996). Humidity in Tulkarem reaches high values with an annual average of 70%. In winter, this value increases to an average of 76% during February while in May it reaches its lowest value of 62%. (Arij, 1996).

Table 3.1: Temperature and Relative Humidity during Experiment Period.

Year	Month	Maximum Temperature	Minimum Temperature	Relative Humidity %
1999	April	24.5	13.0	74.0
1999	May	30.0	17.5	62.0
1999	June	30.5	20.5	61.0
1999	July	32.0	23.0	63.0
1999	August	33.0	24.0	59.0
2000	February	17.5	8.5	77.0
2000	March	19.0	10.0	80.0
2000	April	25.5	14.5	67.0
2000	May	27.5	16.5	66.0
2000	June	31.2	20.9	69.0

Source: Tulkarem Department of Metrology, Unpublished data.

3.2 Land Preparation:

This study was carried out under a plastic house with 33m long, 4m high, 37m width, that was laid in north south direction with an area of one dunum.

Soil was prepared by plowing first, leveling, and sterilization with methyl bromide and then laying out the drip irrigation system.

3.3 Plant Material:

Seeds of Parthenocarpic cucumber (Super, Anas, and IV36) were grown at a local nursery, for 3 weeks then transplanted into the plastic house.

3.4 Planting:

Land preparation was done, the drip irrigation system was laid out, distances between rows were 125 cm and between plants were 40 cm. The irrigation treatments used were irrigation three times a week by drip irrigation according to the recommendation of the Ministry of Agriculture. The fertilizer was applied by hand (manually).

Some physical soil properties for the soil layers are shown in table 3.2.

Table 3.2: Selected Physical Properties of the Soil at the Experiment Area for the First Experiment.

Soil layer (cm)	Clay %	Silt %	Sand %	Soil texture Class
0	26	10	64	Sandy clay loam
50	26	10	64	Sandy clay loam

3.4.1 First Experiment:

In this experiment, the effect of different nitrogen forms on the growth of cucumber was studied. Two cucumber cultivars were used (Anas and Super).

Three different forms of nitrogen were used by mixing four types of fertilizers, (Ammonium sulfate, 20-20-20, KNO₃, and Urea). The amount of fertilizer applied was adjusted according to plant growth phase. Three phases were considered according to the plant age. The first phase from 0-14 days, the second from 15-35 days and the third from 36 days to the plant maturation. Tables 3.3-3.7, show the sources and amounts of fertilizers, which were applied at each stage. The three nitrogen forms were considered as the treatments and were applied for both cultivars. The treatments were arranged as a factorial treatment and were put in a complete randomized design. The Design has four replicates; each replicate consisted of five plants. Each treatment received the same net amount of nitrogen, potassium, and phosphorous from different sources. (Table 3.7)

Table 3.3: Amount of fertilizers applied in the first phase (0-14 days) in kg/ dunum

Treat.	Ammonium sulfate	20-20-20	KNO ₃	Urea	Total Pure N
First	0.98	5.25	3.78	0.00	1.75
Second	0.00	5.25	3.78	0.45	1.75
Third	0.39	5.25	3.78	0.22	1.72

Table 3.4: Amount of fertilizers applied in the second phase (15-35 days) in kg/ dunum

Treat.	Ammonium sulfate	20-20-20	KNO ₃	Urea	Total Pure N
First	2.94	15.75	11.34	0.00	5.24
Second	0.00	15.75	11.34	1.35	5.25
Third	1.18	15.75	11.34	0.65	5.17

Table 3.5: Amount of fertilizers applied in the third Phase (36-end days) in kg/ dunum

Treat.	Ammonium sulfate	20-20-20	KNO ₃	Urea	Total Pure N
First	9.49	43.75	31.94	0.00	14.89
Second	0.00	43.75	31.94	4.34	14.90
Third	4.78	43.75	31.94	2.17	14.90

Table 3.6: Amount of fertilizers applied in all phases in Kg / dunum

Treat.	Ammonium sulfate	20-20-20	KNO ₃	Urea	Total Pure N
First	13.41	64.75	47.06	0.00	21.88
Second	0.00	64.75	47.06	6.14	21.90
Third	6.35	64.75	47.06	3.04	21.79

Table 3.7: Total pure N, P, K applied in all phases Kg/dunum

Treat.	Total Pure N	Total Pure P	Total Pure K
First	21.88	5.57	28.72
Second	21.89	5.57	28.72
Third	21.79	5.57	28.72

Yield harvesting started on June 15.1999. Mature fruits were harvested by hand three times a week. The study was terminated on August 20.1999. Data were recorded during and at the end of the growing season. Total yield/plant, Plant height, number of leaves, together with soil samples were measured and analyzed. Plant height was measured from soil surface to the top of the plant using a measuring tape.

3.4.2 Second Experiment:

Effects of rates of nitrogen on soil, plant growth, and yield (qualitative and quantitative) of IV36 summer cucumber were investigated. Therefore, plants received different amounts of nitrogen fertilizers at different plant stages, in the form of 20-20-20, KNO_3 , Ammonium sulfate, 17-10-27. A set of plants was not fertilized with N (control). Nitrogen was applied via fertigation by hand once a week followed by ordinary irrigation

Five different total nitrogen levels were used in this experiment. The amount of nitrogen was adjusted according to different plant growth stages. The amount was computed from different fertilizer types according to plant

requirement. The amounts of K, and P were fixed. The amounts of N, P, K used are shown in tables 3.8-3.12. The source of nitrogen used was Potassium nitrate, Ammonium sulfate, and compound fertilizer of 20-20-20 and 17-10-27 forms. These forms were used to ensure the provision of Phosphorus and Potassium to plants. Each level of Nitrogen was considered as a treatment and was arranged in a CRD with 5 replicates. Each replicate consisted of 20 plants. Fertilizers were applied as side dressing followed by irrigation.

Table 3.8: Amount of Fertilizers Applied in the First Phase (0-14 days) in kg/ dunum

Treat.	Phosphoric acid (L)	Potassium sulfate	KNO ₃	Ammonium sulfate	20-20-20	17-10-27	Total Pure N
First	6.048	4.2	0	0	0	0	0
Second	6.048	0	5.5	1.6	0	0	1.05
Third	0	0	0	0	10.5	0	2.1
Fourth	0	0	0	5.0	10.5	0	3.15
Fifth	0	0	0	10.0	10.5	0	4.20

Table 3.9: Amount of Fertilizers Applied in the Second Phase (15-35 days) in kg/ dunum

Treat.	Phosphoric acid (L)	Potassium sulfate	KNO ₃	Ammonium sulfate	20-20-20	17-10-27	Total Pure N
First	9.07	16.8	0	0	0	0	0
Second	9.07	1.34	20.19	0	0	0	2.62
Third	0	0	0	0	0	30.87	5.25
Fourth	0	0	0	12.50	0	30.87	7.87
Fifth	0	0	0	25.0	0	30.87	10.50

Table 3.10: Amount of Fertilizers Applied in the Third Phase (36-end days) in kg/ dunum

Treat.	Phosphoric acid (L)	Potassium sulfate	KNO ₃	Ammonium sulfate	20-20-20	17-10-27	Total Pure N
First	40.32	75.04	0	0	0	0	0
Second	40.32	0	98.28	0	0	0	12.76
Third	0	0	0	0	0	138.93	23.52
Fourth	0	0	0	57.51	0	138.93	35.56
Fifth	0	0	0	114.18	0	138.93	47.60

Table 3.11: Amount of Fertilizers Applied in All Phases in Kg/ dunum

Treat.	Phosphoric acid (L)	Potassium sulfate	KNO ₃	Ammonium sulfate	20-20-20	17-10-27	Total Pure N
First	55.438	96.04	0	0	0	0	0
Second	55.438	1.34	124.0	1.60	0	0	16.43
Third	0	0	0	0	10.5	169.80	30.87
Fourth	0	0	0	75.0	10.5	169.80	46.58
Fifth	0	0	0	149.20	10.5	169.80	62.30

Table 3.12: Total Pure N, P, K Applied in All Phases Kg/dunum

Treat.	Total Pure N	Total Pure P	Total Pure K
First	0	19.2	48.02
Second	16.43	19.2	48.02
Third	30.87	19.2	48.02
Fourth	46.58	19.2	48.02
Fifth	62.30	19.2	48.02

Yield harvesting was started on March 22.2000. Mature fruits were harvested by hand three times/week and then graduated into marketable and non-marketable fruits. The study was terminated on May 20.2000.

The total yield/plant (gm), marketable yield/plant (gm), non marketable yield/ plant (gm), were weighed for each replicate for each treatment during the harvesting period which extended from (March, 22.2000- May, 20.2000).

The total number of fruit /plant of both marketable (2.5-3.5cm in diameter) and non-marketable fruits (>3.5 cm in diameter) were recorded.

3.5 Soil and Plant Analysis:

3.5.1 Soil Analysis:

Prior to planting each experiment, the nutrient status of surface (0-20cm) and sub surface (35cm), (50cm) soil layers, and some chemical and physical properties of the soil were determined as shown in table 3.10. Seventy-five soil samples were also taken at the end of the experiment. Composite soil samples (by Auger) were collected from each replicate of each treatment from three depths (0-30),(60),and (1m).

For chemical analysis of soil, one soil sample was taken from each replicate of each treatment, and analyzed for: N, P, K, Cl, Ca^{++} , Mg^{++} , Na, TDS, SAR, pH and electric conductivity (EC) determination.

Total nitrogen was measured by micro-Kjeldhal method as described by Bremner (Bremner, J.M., *et al.*, 1982). Available phosphorous was measured according to Olsen method (Olsen, S.R. *et al.*, 1982).

Potassium was estimated by flame photometry as described by Knudsen (Knudsen, D., *et al.*, 1982).

The following parameters were also measured: electric conductivity (EC) was done using the conductivity bridge and cell (Rhoades, J. D.1982). Sodium was estimated by flame photometry. Calcium and magnesium for soil extract by EDTA Titremetric method, chloride (Cl) for extract by Ardentometric method, hardness (Ca+Mg) by EDTA Titremetric method, total dissolved solids (TDS) by conductivity method.

The soil type was determined according to the percentage of clay, silt and sand by hydrometer test.

3.5.2 Plant Analysis:

Fruits and leaves samples were collected at the end of the second experiment, from plants of each replicate of each treatment and they were prepared for nutrient content determination according to the following methods:

Total nitrogen by micro-kgeldhal method as described by Bremner (Bremner, *et al.*, 1982).

Phosphorus by Calovimetric method (Olsen, *et al.*, 1982), and potassium using flame photometer as described by Knudsen (Knudsen, *et al.*, 1982).

3.5.2.1. Leaf Analysis

Leaf samples were collected at the end of the experiment. 25 recently mature leaves (usually the fourth and the fifth from the growing terminal) were collected randomly from each replicate for each treatment. Sampling was conducted in the morning, when leaf material was turgid. These samples were stored in white nylon bags and placed in a refrigerator for later work (drying).

The leaves of each sample were washed with distilled water, oven dried at 65-70°C for 24-48 hours, then ground and stored for subsequent chemical analysis.

3.5.2.2. Fruits Analysis:

Fruits were picked by hand from each replicate of each treatment. The samples were graded into marketable and non-marketable yields. 25 samples of mature fruits from marketable yields and similar numbers from non-marketable yields were collected randomly.

These fruits were then sliced into small pieces and dried in an oven at 60-70°C to a constant weight, then it was ground and analyzed for total nitrogen.

3.6 Crop Management:

During the growing season, weeds were controlled by hand. Protection against diseases, especially Powdery mildew, Downey mildew, Mites was

done when needed by spraying plants with (Offeer50cc/d, Bifedan120cc/du), (Menbegan400gm/du, aliet240gm/du, Redome1240 gm/du), (Vertimic60 cc/du, Belectran 60 cc/du), Konfedor 100cc/du respectively.

3.7 Data Analysis:

The data were entered into the computer in the form of Excel files and analyzed for estimating the sum of means, sum of squares, degree of freedom, using the two and one way ANOVA model, followed by post hoc analysis for the first experiment and contrast analysis and regression analysis for the second experiment. The analysis was done using the SPSS software for the contrast analysis an optimal fertilizer value was computed when the model was significant.

4- Results and Discussion

4.1.1 Effect of Nitrogen Sources on Cucumber Production:

The effects of nitrogen sources on cucumber production is shown in table 4.1. There was no significant effect of adding different sources of nitrogen on the fruit production for cultivar one (Anas), as shown in appendix E. However, for the cultivar two (Super) there was a significant effect on the production by adding different sources of nitrogen. According to least significant difference (LSD), appendix F there was a significant difference between treatments one (Ammonium Sulfate, 20-20-20, KNO₃) and two (KNO₃, Urea. 20-20-20), and between two and three (Ammonium Sulfate, 20-20-20, KNO₃, Urea) table 4.1. Table 4.1 Shows that yield was higher when ammonium sulfate was estimated and other sources of nitrogen were utilized specially for cultivar two which shows significant differences. For cultivar one the effects were less as the differences were not statistically deferent. This result could be attributed to possible losses of nitrogen from ammonium sulfate through utilization and the availability of nitrates – N to the plant.

Table 4.1 Effect of different nitrogen sources on the production of two cucumber cultivars.

Fertilizers	Average production: Kg/dunum	
	Cultivar one	Cultivar two
Ammonium Sulfate, 20-20-20, KNO ₃	1216.69*a	5067.55b
KNO ₃ , Urea. 20-20-20	1242.32a	5528.15a
Ammonium Sulfate, 20-20-20, KNO ₃ , Urea	1182.94a	5073.98b

• Values followed by the same letter within the same column are not significantly different at 5%

probability level according to LSD method.

The results for the cultivar two are consistent with earlier reports on potato yield (White and Sanderson, 1983; Sekhon and Singh, 1985; Painter and Augustin, 1976; Iritani and Weller, 1987). Anabousi *et al.*, (1997) reported that Urea and Potassium nitrate gave significantly highest marketable and total potato yields however, Urea significantly enhanced potato yields. Other wise, no significant differences were noticed among the different nitrogen sources used for potato. In contrast, superior potato yield was reported when ammonium sulfate was used compared with other nitrogen sources (Bundy *et al.*, 1986). However, Carter and Bosma, 1974) found that ammonium nitrate or Urea at 180 Kg N/ha resulted in maximum production of potato tuber. Jack E. Rechcigl (1995), when plants receiving an insufficient supply of N, are stunted and have chlorotic leaves, i.e. leaves that are yellow to yellow green often fail to flower or set seed which will lead to increase the crop production.

4.1.2 Effect of Nitrogen Sources on Vegetative Growth:

1- Plant Height:

The effect of nitrogen source on cucumber height is illustrated in table 4.2. There was no significant effect of adding different sources of nitrogen on plant height for both cultivars. According to LSD methods there was no significant differences between treatments, appendices G and H.

Table 4.2 Effect of different nitrogen sources on the length of two cucumber cultivars.

Fertilizers	Average Length cm	
	Cultivar one	Cultivar two
Ammonium Sulfate, 20-20-20, KNO ₃	289.33*a	322.88a
KNO ₃ , Urea, 20-20-20	278.46a	326.06a
Ammonium Sulfate, 20-20-20, KNO ₃ , Urea	272.46a	320.75a

* Values followed by the same letter within the same column are not significantly different at 5% probability level according to LSD method.

2- Number of Leaves:

The effect of nitrogen form on number of leaves is shown in table 4.3. For the first cultivar the highest average number of leaves (69.5) was obtained from plants received (21.88 kg N/dunum) from ammonium sulfate, 20-20-20, and KNO₃. This number was significantly different from plants received (21.79 Kg N/dunum) only from ammonium sulfate, 20-20-20, KNO₃ and Urea. For the second cultivar the highest average number of leaves (54.63) was obtained from plants received (21.88 Kg N/dunum) from ammonium sulfate, 20-20-20, and KNO₃. This number was not significantly different from plants received (21.89 Kg N/Dunum) from 20-20-20, KNO₃ and Urea only. Other treatments effects were not significantly different, (appendix I).

However there was no significant effect from adding different sources of nitrogen on the leaf numbers for cultivar two table 4.3, appendix J.

Table 4.3 Effect of different nitrogen sources on number of leaves for the two cucumber cultivars.

Fertilizers	Average Number of leaves	
	Cultivar one	Cultivar two
Ammonium Sulfate, 20-20-20, KNO ₃	69.50*a	54.63a
KNO ₃ , Urea, 20-20-20	62.69ab	50.13a
Ammonium Sulfate, 20-20-20, KNO ₃ , Urea	60.56b	51.81a

* Values followed by the same letter within the same column are not significantly different at 5% probability level according to LSD method.

4.1.3 Chemical Analysis:

4.1.3.1 Soil Analyses Prior to Planting:

Prior to planting, some physical properties of soil were determined. The results are shown in table 4.4.

Table 4.4: Selected Physical Properties of the Soil at the Experiment Area for the First Experiment.

Soil layer (cm)	Clay %	Silt %	Sand %	Soil texture Class
0	26	10	64	Sandy clay loam
50	26	10	64	Sandy clay loam

4.1.3.2 Soil Analyses at the End of the Experiment:

For soil analysis at the end of the experiment, different NO₃⁻ rates were observed at different depths for the three treatments without a clear trend. This could be attributed to lower leaching rates as a result of the use of trickle irrigation in green houses where

no leaching was applied to the green house during the growing season. This is also clear from the high EC rates observed at the surface of soil. In tables 4.5, 4.6 show that high amounts of nitrates remain in the soil at the end of the growing season therefore, the amount of N- fertilization added could be high.

Table 4.5 Chemical Properties of the Soil at 50 cm Depth for the Different N Treatment for the First Cultivar

TREAT	Ec ds/m	TDS	Na- PPM	Ca Meg/l	No3 PPM	Ca+Mg Meg/l	K PPM	P PPM	CL Mg/l	Mg Meg/l
1	2.1	1344	250	5	185	17.5	24	189	355	12.5
2	1.6	1024	190	7.9	465	15.5	13	223	284	7.6
3	3.4	2176	260	10.1	390	22.5	15	167	496	12.4

Table 4.6 Chemical Properties of the Soil at 0 cm Depth for the Different N Treatment for the First Cultivar

TREAT	Ec ds/m	TDS	Na- PPM	Ca Meg/l	No3 PPM	Ca+Mg Meg/l	K PPM	P PPM	CL Mg/l	Mg Meg/l
1	4	2560	160	8.9	890	19	38	46.6	248	10.1
2	2.5	1600	290	11.5	850	27	39	223	355	15.5
3	3.5	2240	310	12.2	600	22	37	211	425	10.8

Table 4.7 Chemical Properties of the Soil at 0 cm Depth for the Different N Treatment for the Second Cultivar

TREAT	Ec	TDS	Na	Ca	No ₃	Ca+Mg	K	P	CL	Mg
	ds/m		PPM	Meg/l	PPM	Meg/l	PPM	PPM	Mg/l	Meg/l
1	1.5	960	58	4.3	240	9.5	31	67	178	5.2
2	4.1	2624	51	13	475	23	36	33	319	10
3	3.6	2304	270	15	1065	17	18	200	319	2

4.2.1 Effect of Nitrogen Rate on Cucumber Total Yield:

The effect of nitrogen rate on cucumber yield is shown in table 4.8 There was a significant effect of adding different levels of nitrogen on both total and marketable yield of cucumbers. A significant quadratic effect of nitrogen on production was exhibited. However for total yield the maximum production was estimated by using (31.45 Kg N/du). Regarding the non-marketable weight the quadratic effect was not significant. The distribution of cucumber production over the harvesting period is shown in figures 4.1,4.2,4.3 for total, marketable and non marketable yield respectively. For both total and marketable yield the production was similar at different harvesting periods for the five nitrogen levels. However, the non marketable yield showed a non steady production pattern mainly at week four for treatment 5 figure 4.3.

Increasing amount of fertilizer from T1 (0 Kg N/du) to T2 (16.43 Kg N/du) caused 23% increase in total yield. However when the level was increased to (30.87 Kg N/du)

only 15% significant increases in total yield was obtained. while yield decreased by 21% and 4% when fertilizer was increased from T3 (30.87 Kg N/du) to T4 (46.58 Kg N/du) and from T4 (46.58 Kg N/du) to T5 (62.30 Kg N/du) respectively. These findings are in agreement with earlier reports. Ruize *et al.*, (1998) reported that the effect of N fertilization on commercial yield was great with (20gm⁻²) application rate and the lowest with (2.5gm⁻²) rate. High N treatment of 40gm⁻², resulted is a yield reduction by 30%.

Commercial yield depends on the N application rate (Mattson *et al.*, 1991; Lopez-Cantarero *et al.*, 1997). Evidence indicates that excess N can encourage excess vegetative production and simultaneously reduce crop yield (Davenport, 1996). In addition, lopez-Cantarero *et al.*, (1997) demonstrated that increased N fertilization augmented non commercial production at the expense of commercial yield, in addition, Lopes-Cantarero *et al.*, (1997) demonstrated that increased N fertilization augmented noncommercial production at the expense of commercial yield. Our results show that increasing fertilizer up to a certain point will increase yield significantly then the yield starts to decrease. This decrease in response of plant to adding fertilizer was expected, where the first, second, and third increment gave the highest increase, while the later increment gave progressively lower increase. Increasing amount of fertilizer might made the plant to start to suffer from a new limiting factor rather than N- fertilization. N- fertilization applied for T1 (0 Kg N/du) was not enough to produce high yield which caused plant to suffer from fertilizer stress, so increasing fertilizer in T3 (30.87 Kg N/du) caused a high increase of yield produced under T3 and the plant

reached a stage of fertilizer sufficiency. Therefore increasing the amount of fertilizer applied for T4 (46.58 Kg N/du) and T5 (62.30 Kg N/du) did not give the same increase in yield. On the other hand, the yield started to decrease from T4 to T5, this had led to less fertilizer utilization by the plant, which may be due to the fertilizer accumulation below the root zone, or it could be as a result of fertilizer loss.

Production Rate:

Maximum production yield was obtained at the beginning of season with T3 (30.87 Kg N/du) fig.4.1. Treatment 3 continued to give the highest yield up to the 8th week from the total season. The yield decreased by increasing fertilizer amount for T4 (46.58 Kg N/du) and T5 (62.30 Kg N/du) during this period, which indicated that fertilizers applied in excess amounts for plants in T4 and T5 from early until 8 weeks from the total season. Yield function is presented in fig 4.1. Yield increased by increasing the amount of fertilizers up to a certain limit and then it declined. This decrease might have been due to the loss of fertilizer into surface soil or ground soil or to the accumulation of fertilizer which may cause toxicity to plant (Donahue, et al., 1983). Also the decrease may result from leaching of nutrients away from the plants roots or because of competition between elements (Jack E. Rechcigl, 1995).

Daniel (1977) reported that increasing the amount of pre plant N fertilization from 67 to 134 Kg/ha resulted in greater yields of cucumbers. The effect of N fertilization on yield was independent of plant population. This higher yield was primarily due to a greater number of smaller pickles.

If N fertilizer was applied at rates above 134 Kg N/ha, lower yield was obtained. Results were reported by McCollum and Miller (1971) who showed that the rate of N fertilization above 180 Kg/ha did not improve yields of multiple-picked cucumber over a rate of 90 Kg N/ha. Bishop *et al.*, (1969) reported that satisfactory yields from pickling cucumbers harvested several times when 50 Kg N/ha were broadcast before planting. McCall *et al.*, (1958) observed maximum yields of pickling cucumbers to which the N fertilizer was broadcast before planting at rates to 56 Kg/ha compared to side dressed at planting.

4.2.2. Effect of Nitrogen Rate on Marketable Yield:

Effect of fertilizer treatments on marketable yield was similar to total yield. The marketable yield for the five treatments are presented in table 4.8. After the regression analysis there was a significant quadratic model between production (marketable) and nitrogen rate. The estimation of the maximum marketable yield for the quadratic model was obtained at (27.2 Kg N/du). The equation is present in legend of table 4.8. Marketable fruits weight increased by 22% from T1 to T2 and by 13% from T2 to T3 and this was significantly increased, and decreased by 29% and 9% for T4 and T5 from T3. The result shows that increasing fertilization up to a certain point will increase yield significantly, then the yield start to decrease.

Treatment 3 continued to give the highest marketable yield up to the 8 weeks for the total season, and the yield decreased by increasing fertilizer amount. T4 and T5 showed a decrease in marketable yield from the beginning of the season this may be due to the excess amount of fertilization for plant in T4 and T5. Yield function is

presented in fig. 4.2. This decrease in marketable yield might have been due to the increase in non-marketable yield. With higher nitrogen levels, this illustrated that as fertilizer had increased the size of fruits increased significantly this due to the increasing of the cell number and cell size especially cell division (Devlin and Witham, 1983).

Doss *et al.*, (1977) reported that the higher N rate increased marketable cucumber yields for the spring crops, but had no effects on the other crops. Marketable yields were considerably higher in the spring than in the fall every year.

Economical Analysis:

The economic theory says that the maximum profit obtained when the marginal values of production equal the price of input. The marginal production value equal the marginal physical production multiplied by the price of output, so we obtained the marginal physical production by taking the first derivative of the equation, so we maximize the profit when:

$$MPP \cdot PY = PX$$

Where: - MPP= Marginal Physical Product.

- PY= Price of output (Cucumber) = 0.695 NIS.

- PX= Price of Input (Pure Nitrogen Fertilizer)= 14.0 NIS.

Regression analysis was used in order to determine the relationship between the amount of fertilizer added as independent variable and the marketable output as dependent variable.

By using regression analysis a quadratic relationship was found between the marketable fruit production as dependent variable and pure nitrogen fertilizer as independent variable appendix L as following:

$$TMW = 6126.22 + 113.25N - 2.083N^2 \text{-----}(1)$$

$$R^2 = 0.31, F = 5.02$$

Where:

TMW = Total Marketable Weight

N = Pure Nitrogen Fertilizer

According to the equation No. 1

$$MPP = (113.25 - 4.17N)$$

$$MPP * PY = PX \rightarrow (113.25 - 4.17N) * 0.695 = 14 \rightarrow N = 22.34$$

So the amount of pure nitrogen fertilizer which maximize the profit of farmers is 22.34 Kg, and the amount of pure nitrogen fertilizer which give the maximum production is 27.2 Kg

4.2.3.Effect of Nitrogen Rate on Non Marketable Yield:

Total non-marketable yield for the five treatments are presented in table 4.8. Non marketable yield for T1, T2, T3, T4, and T5 were 861, 1101, 1346, 1728 and 1941 Kg/du respectively. This indicated that when the fertilizer had increased the size of fruits increased significantly, therefore it resulted in higher non-marketable production. Non marketable fruit weight increased from T1 to T5 significantly.

Increasing amount of fertilizer from T1 to T3 caused 56% significant increase in non-marketable yield. Yield increased by 12% with increasing fertilizer rate from (46.58Kg N/du) to (62.30 Kg N/du).

Anabousi *et al.*, (1997) reported that both the “marketable and non marketable ” “yields and tuber numbers” had positive effects on total yields of potato and tuber numbers, respectively. This fact along with the lack of correlation between marketable (yield or number) and non marketable (yield or number), indicate that increased total yields or numbers were associated with increased marketability and non marketability tubers. Yield functions are presented in fig. 4.3. Yield increased by increasing the amount of fertilizer up to a certain limit. This increase then started to decrease.

Maximum yield obtained in one harvest occurred in the second week in T4 fig.4.3, and T5 continued to give the highest yield of non marketable yield up to the fourth week from the total season, and then the yield decreased until the fifth week after that the yield continued to increase up to a certain limit. For all treatments the non marketable yield start to increase from the second week, when the amount of fertilizer started to increase, the non marketable yield increased. This may be due to the increasing amount of water that might be absorbed by the plant because of the stress conditions that might the plant suffered from it (Devlin and Witham, 1983).

Figure 4.1 Effect of Nitrogen Rate on Total Fruit Weight

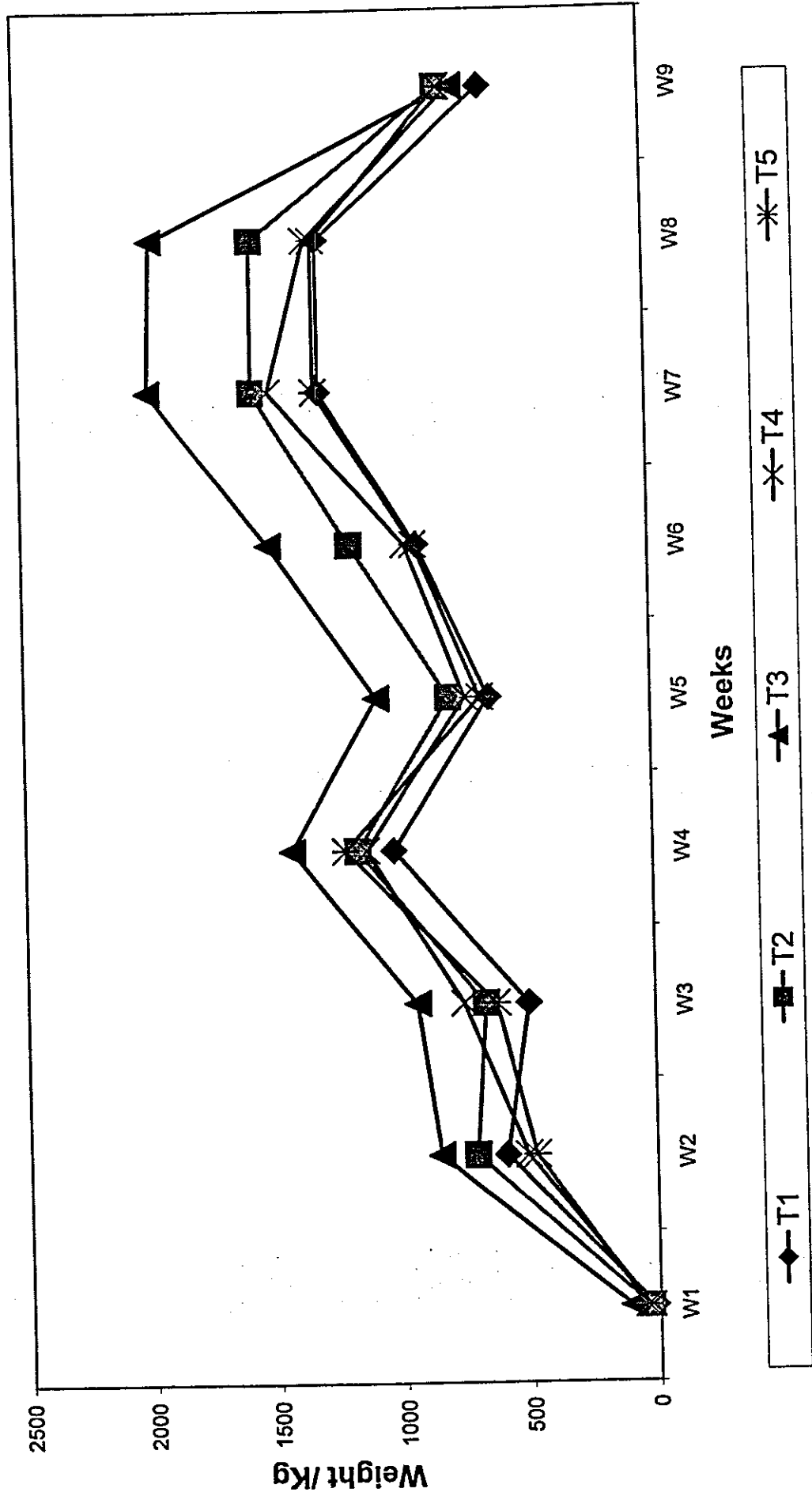


Figure 4.2 Effect of Nitrogen Rate on Marketable Fruit weight

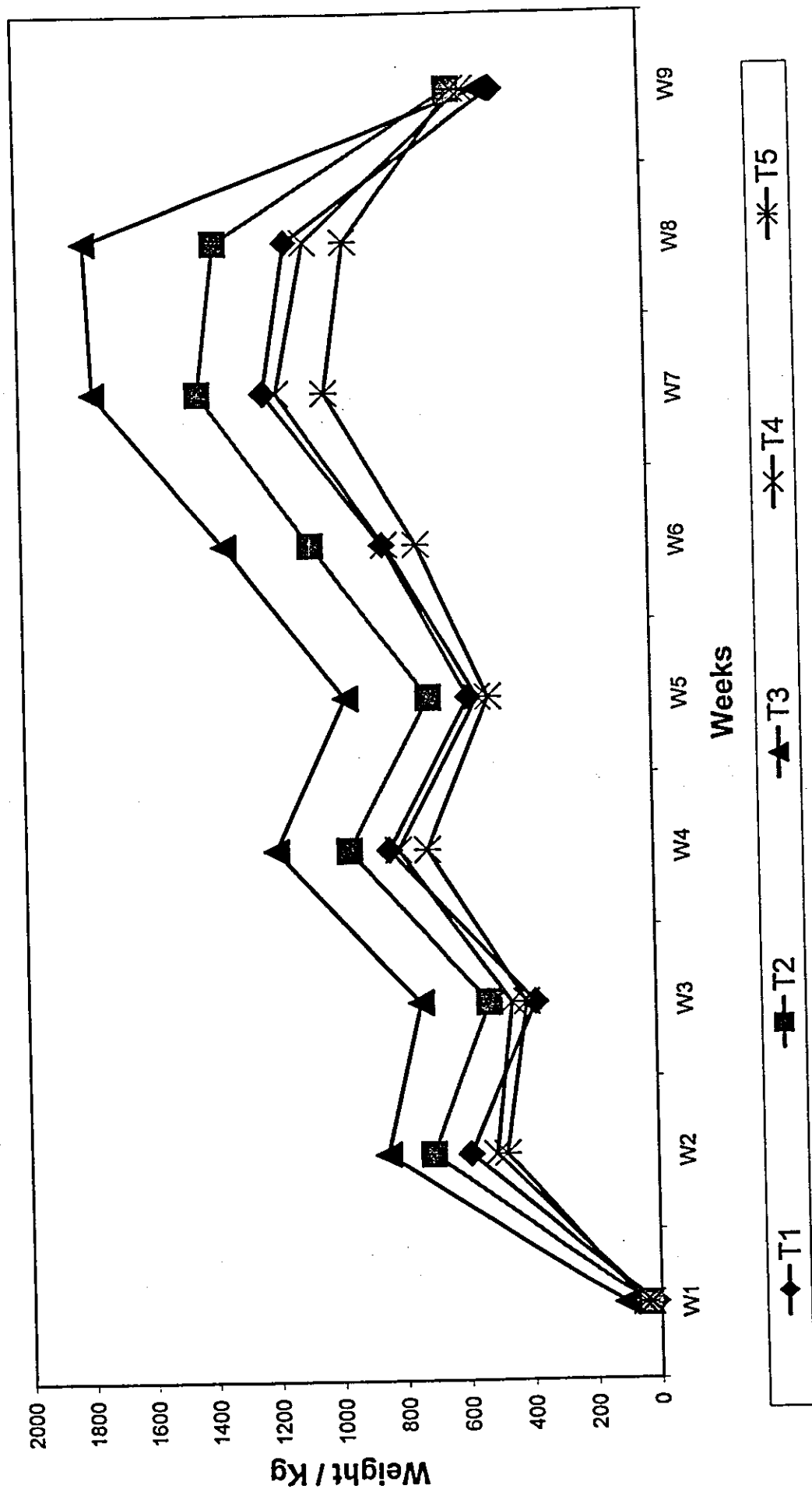


Figure 4.3 Effect of Nitrogen Rate on Non Marketable Fruit Weight

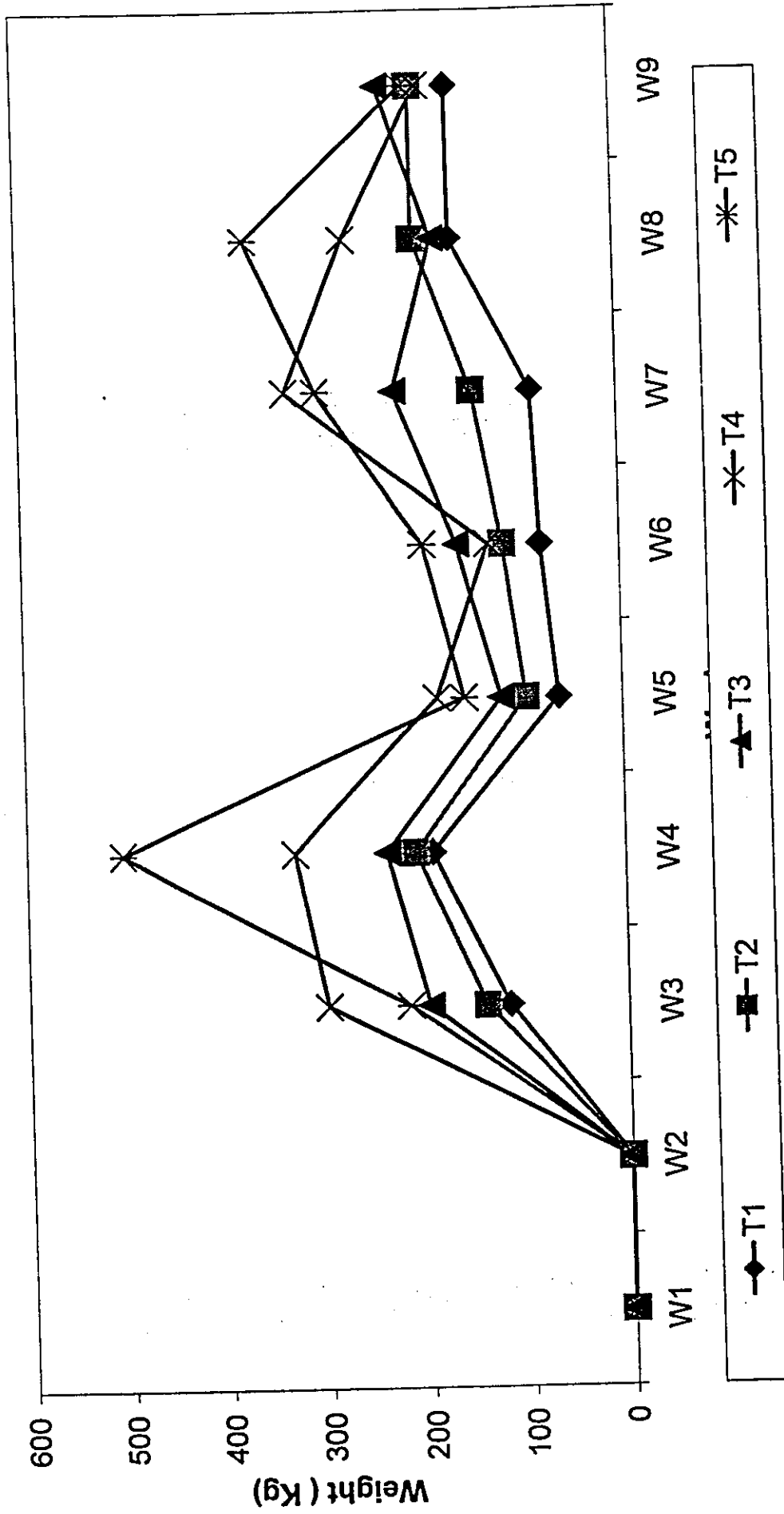


Table 4.8 Effect of Nitrogen Rate on Cucumber Yield

Treat	Marketable Weight Kg/Dunum	Non-Marketable Weight Kg/Dunum	Total Weight Kg/Dunum
0	6030	861	6891
16.43	7364	1101	8465
30.87	8374	1346	9721
46.58	5966	1728	7694
62.30	5430	1941	7371

Statistical Analysis	Marketable fruit Weight	Non marketable Fruit Weight	Total Fruit Weight
ANOVA	0.021	000	0.063
Regression:			
Linear	0.207	000**	0.931
Quadratic	0.007*	0.872	0.012***

$$* \text{Tmw} = 6126.22 + 113.248 \text{ N} - 2.083 \text{ N}^2$$

$$** \text{Tnw} = 832.96 + 18 \text{ N}$$

$$*** \text{Tw} = 6971.5 + 129.6 \text{ N} - 2.06 \text{ N}^2$$

Where:

Tmw: Total Marketable weight

Tnw: Total Non Marketable weight

Tw: Total Fruit weight

N: Nitrogen amount, Kg/Du

4.2.4 Effect of Nitrogen Rate on Cucumber Fruit Number:

The effect of nitrogen rate on cucumber fruit is shown in table 4.9. There was a significant effect of adding different levels of nitrogen on both marketable and total fruit number of cucumber. Both marketable and total fruit numbers exhibited a significant quadratic effect of nitrogen on fruit number. The estimation of the maximum marketable fruit number for the quadratic model was obtained at (27.53 Kg N/du). However for the total fruit number, the maximum production was estimated by using (30 Kg N/du). Regarding the non-marketable fruit number the quadratic effect was not significant. The distribution of cucumber fruit numbers over the harvesting period is shown in figure 4.4, 4.5 and 4.6 for total, marketable and non marketable fruit numbers respectively. For both total and marketable fruit numbers, the numbers were similar at different harvesting period for the five nitrogen levels. However, the non-marketable fruit numbers showed a non-steady response mainly at week four for treatment 5 figure 4.6.

4.2.5 Effect of Nitrogen Rate on the Total Number of Fruit:

The total numbers of fruit for the five treatments are presented in table 4.10. Average fertilizers from pure N applied For T1, T2, T3, T4, and T5 was 0, 16.43, 30.87, 46.58 and 62.30 Kg N/du respectively. There is a significant difference in the amount of fertilizer applied between treatments. Total number of fruit for T1, T2, T3, T4 and T5 were 84047, 102351, 122201, 88001 and 86073 respectively. Increasing amount of fertilizer from T1 to T2 caused 21% significant increase in total number. Total number

increased by 19% significant increase in total number when increasing fertilizer applied from T2 to T3, while total number decreased by 28% and 2% when increasing fertilizer from T3 to T4 and from T4 to T5 with no significant differences between them, also there were significant differences between T3 and T5. The result shows that increasing fertilization up to a certain point will increase total number significantly then the total number start to decrease.

Fertilizer application in T3 caused a high number of total yield and the plant reach a stage of fertilizer sufficiency. Increasing the amount of fertilizers applied for T4 and T5 did not give the same increase in total number, on the contrary the yield start to decrease from T4 to T5. Maximum number of yield obtained occurred at the beginning of season in T3 started from the first week (fig.4.4). Treatment 3 continued to give the highest yield up to the 8th week from the total season, and the total number started to decrease. T4 and T5 gave the lowest number of yield because of increasing the fertilizer amount, which indicate that fertilizer application was in excess amount for plant which made plant suffer from a new limiting factor such as toxicity (Donahue, *et al.*, 1983). Total number function for yield is presented in figure 4.4.

Appendix N: illustrates analysis of variance (ANOVA) table for total number of yield for cucumber. It is clear that there were significant differences in total number of yield parameter among treatments.

El-Sharkawy *et al.*, (1991) reported that 80 Kg N/acre was most suitable level of nitrogen fertilization for producing high number of fruits/plants.

4.2.6 Effect of Nitrogen Rate on Marketable Fruit Numbers:

Effect of fertilizer treatments on numbers of marketable yield was similar to its effect on total number. Number of marketable yield for the five treatments are presented in table 4.9. Number of marketable yield for T1, T2, T3, T4, and T5 were 77563, 94694, 112694, 75132 and 71306 per dunum respectively. Numbers of marketable yield increased by 22% from T1 to T2 and by 19% from T2 to T3 and this was significantly increased, and was decreased by 33% and 5% for T4 and T5 from T3. The difference between all numbers of marketable fruit yield was lower than differences in the total number. From table 4.9, we can see that the maximum number (112694 /du) was obtained by fertilizing cucumber with treatment 3 (30.87 Kg N/du). On the other hand, the lowest number (71306 /du) was obtained by fertilizing cucumber with treatment 5 (62.30 Kg N/du).

Number of marketable yield function is presented in fig 4.5. Treatment 3 gave the highest number. It continued to increase until a certain point, after that, it started to decrease. T4 and T5 showed a decrease in number of marketable fruit from the beginning of the season this is due to the excess amount of fertilizer for plant in T4 and T5. This decrease has been due to the increase in number of non marketable yield. This illustrated that as fertilizer had increased the number of non marketable fruit increased significantly.

54277.1

Appendix O: illustrates analysis of variance (ANOVA) table for marketable fruit number for cucumber. It is obvious that there were significant differences in number of marketable yield parameter among treatments.

4.2.7 Effect of Nitrogen Rate on Non Marketable Fruit Number:

The numbers of non-marketable cucumber fruit for the five treatments are presented in table 4.10. Number of non-marketable yield for T1, T2, T3, T4, and T5 were 6484, 7656, 9506, 12868 and 14765 Kg/du respectively.

From table 4.9, we can see that the maximum number on non-marketable (14765 /du) was obtained by fertilizing cucumber with treatment 5 (62.30 Kg N/du). On the other hand, the lowest number (6484 Kg/du) was obtained by fertilizing cucumber with treatment 1 (0 Kg N/du). This illustrated that as fertilizer had increased the number of non-marketable yield increased significantly from T1 to T5. If a plant is supplied with high concentrations of nitrogen, there is attendance to increase cell number, cell size and especially cell deviation with an overall increase in leaf production (Nelson, et al., 1959).

Increasing the amount of fertilizers from T1 to T3 increased the number 46% significantly, and increased by 14% when increasing fertilizer applied from T4 to T5. Number of non marketable yield function is presented in fig. 4.6. Maximum number started from the second week in treatment 5 fig.4.6. T5 continued to give the highest number up to the fourth week from the total season, then the number decreased to a certain point after that it started to increase. For all treatments the number of non marketable started to increase from the second week when the fertilizer amount started to increase. This shows that as fertilizer amount increases the number of non marketable fruit increases significantly.

Appendix P: illustrates analysis of variance (ANOVA) table for number of non marketable yield for cucumber. It is obvious that there were significant differences in number of non marketable yield parameter among treatments.

Figure 4.4 Effect of Nitrogen Rate on Total Fruit Number

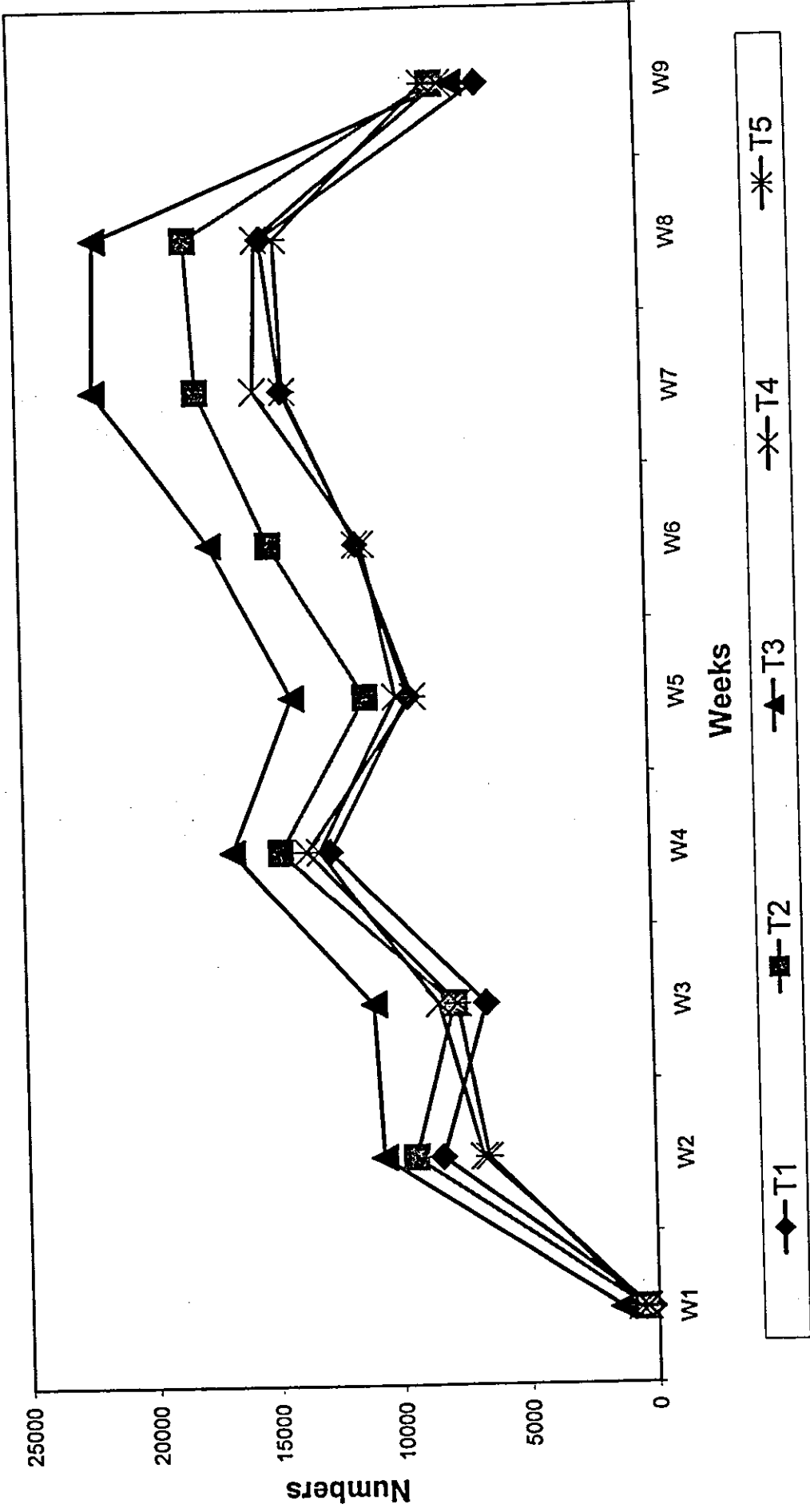


Figure 4.5 Effect of Nitrogen Rate on Marketable Fruit Number

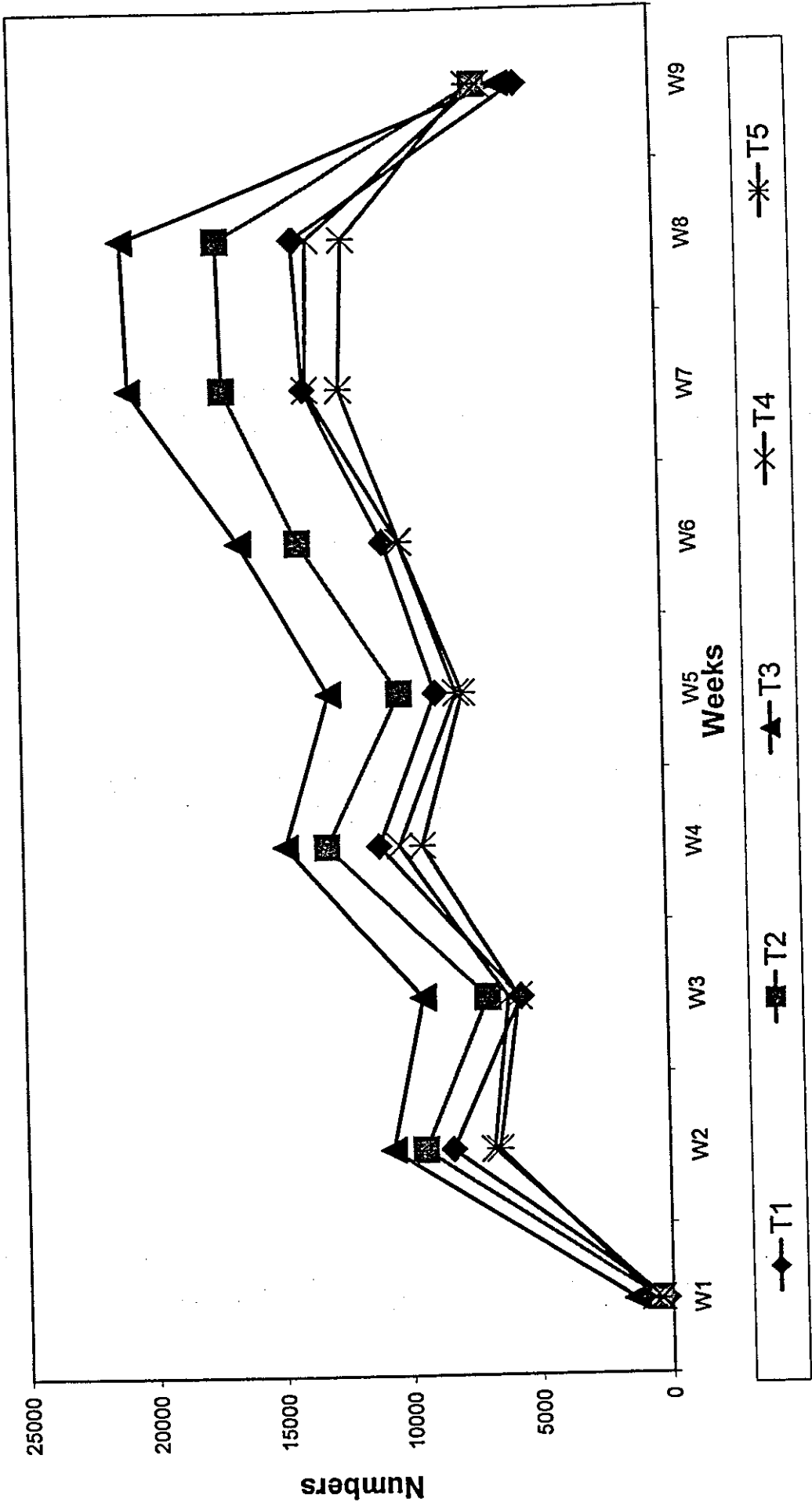


Figure 4.6 Effect of Nitrogen Rate on Non Marketable Fruit Number

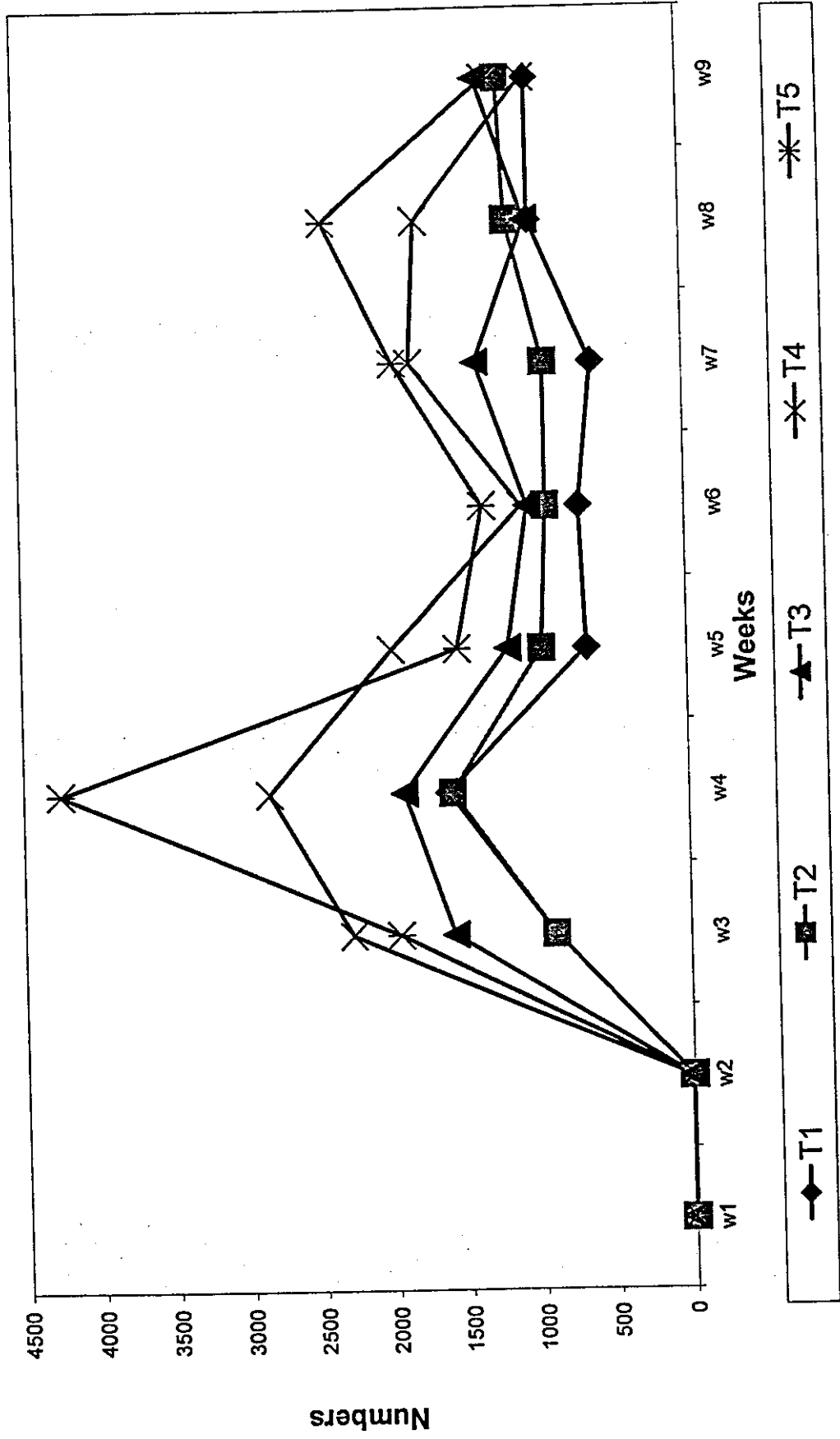


Table 4.9 Effect of Nitrogen Rate on Cucumber Fruit Number

Nitrogen, Kg/Dun	Marketable Fruit No./ Dunum	Non marketable Fruit No./Dunum	Total Fruit No./ Dunum
0	77563	6484	84047
16.43	94694	7656	102351
30.87	112694	9506	122201
46.58	75132	12868	88001
62.30	71306	14765	86073

Statistical Analysis	Marketable fruit Numbers	Non marketable Fruit Number	Total Fruit Number
ANOVA	0.016	000	0.031
Regression:			
Linear	0.254	000**	0.713
Quadratic	0.007*	0.380	0.010***

$$* T_{mn} = 78763.98 + 1559.18 N - 28.31N^2$$

$$** T_{nn} = 5864.84 + 140.58N$$

$$*** T_n = 85062.43 + 1645.08N - 27.43N^2$$

Where:

T_{mn}: Total Marketable Numbers

T_{nn}: Total Non Marketable Numbers

T_n: Total Fruit Numbers

N: Nitrogen amount, Kg/Dunum

4.2.8 Chemical Analysis:

The analysis of variance for plant total nitrogen is present in appendix (Q, R).

4.2.8.1 Soil Analysis:

Soil Analysis Prior to Planting:

Prior to planting, the nutrient status at three soil depths (0-20 cm), (20-35cm) and (35-50cm), as well as some chemical and physical properties of the soil at different depths were determined. The results are presented in table 4.10.

Table 4.10 Selected physical and chemical proprieties of the soil at the experiment area for the second experiment:

Soil depth - Cm	Sand %	Silt %	Clay %	Texture	CaCo3 %	pH	K ⁺ PPM	Cl ⁻ PPM	Mg ⁺⁺ Meq/L	Ca ⁺⁺ Meq/L	Hardness Meq/L	EC dS/m
0-20	10	20	70	Clay	12.7	7.81	360	425.4	12.3	18.7	31	6
20-35	20	15	65	Clay	13.2	7.62	380	407.6	9.3	17.7	27	5
35-50	15	15	70	Clay	13.6	7.54	330	354.5	7.6	14.4	22	4.8

Soil Analysis at the End of the Experiment:

The results of the soil analysis which was given from the laboratory can not be explained, therefor we did not discuss this part of results

4.2.8.2 Nitrogen Plant Analysis:

a- Fruits Analysis:

The analysis of N in the fruit under different treatments exhibited significant differences between treatments table (4.11). Analysis of variance for fruit nitrogen content is shown in appendix Q. The highest N content was obtained in fruit samples in both treatments 4 and 5, the level was significantly different from other treatments. The greatest concentration of fruit total nitrogen was obtained by using T5 as illustrated in table 4.11. However all the nitrogen treatment used increased the fruit total nitrogen compared the control. The percentage of fruit total nitrogen is in agreement with the results obtained by Ruiz and Romero (1998), they reported that the highest NO^{-3} concentrations were found at the high N application rate (40 gm^{-2}). In relation to the nitrogenous compounds the results showed that amino acids, protein, and organic N increased with N rate. This fact could signifies an increase in the synthesis of dry matter in the fruits treated with high nitrogen levels, leading in many cases to deformations in the fruits, thereby diminishing the commercial yield. According to Satti and Lopez, 1994; 1996, Johnson and Decotean, 1996, cucumber fruits treated at medium application rates ($10\text{-}20\text{gm}^{-2}$) could be mostly advisable. These rates resulted in the best commercial yield and fruit quality. Nitrogen concentration and fertilizer treatment utilization by plant is shown in table 4.11. Nitrogen concentration in fruit for T1, T2, T3, T4 and T5 was 2.1, 2.2, 2.2, 2.7 and 2.8% respectively. McCollum (1971) showed that nitrogen percentage in cucumber

fruits ranged from 2.71% to 3.95%, under different N application rates. The highest N% in fruits detected for maximum N – treatments (T5) This support the hypothesis that most of N in T5 was shifted to fruit production, due to the high concentration of T5. According to Maynard (1962), the N content of fruit for the pepper plant was increased significantly as the N levels increased, which indicates that the external N levels were effective in modifying the internal N levels

b- Leaves Analysis:

The nitrogen content in leaves sampled from different nitrogen treatments is shown in table 4.11. The results indicated significant differences among treatments (appendix R). According to LSD method, the highest nitrogen percent was obtained in leaves sampled from treatment 1,2 and 3. The greatest concentrations of leaves total nitrogen were obtained by using T2, as illustrated in table 4.11. However, only T2 increased the total nitrogen in leaves compared to the other treatments (T3, T4, and T5). T5 resulted in the least plant total nitrogen. This is probably due to the greatest plant fresh weight obtained for this treatment, so N is diluted in the plant and distributed in a larger plant size. The percentage of plant total nitrogen is not in agreement with the results obtained by El-Gamassy *et al.*, (1975); Joiner and Smith (1962); and Waters (1965) who reported that N% in mature leaves associated with satisfactory yield and excellent quality of mum was about 3.5%. Higher N concentration in leaves for T2 compared to other treatments may be due to low plants leaves dry weight, which might increased the concentration of N in plant leaves. N in leaves needed for chloroplast pigments used to capture the sun energy and also used in the formation of protein, enzymes, and

vitamins needed to complete the photosynthesis process. While fruits considered as a very strong sink for all nutrients. Our data are not in agreement with Anabousi *et al.*, (1997) who reported that leaf N increased significantly with each increase in nitrogen rate, except for the nitrogen rates more than (25 Kg N/ha). White and Sanderson, 1983; Heutt and White, 1992, demonstrated that leaf N increased with level of N fertilizer applied.

Table 4.11: Effect of Nitrogen Rates on Nitrogen Contents of Fruit and Leaves

Nitrogen Rate Kg / du	% N in Fruit	% N in Leaves
0	2.1 a *	3.62a
16.43	2.2 a	3.74a
30.87	2.2 ab	3.65a
46.58	2.7 bc	2.30b
62.30	2.8 c	2.23b

* Values followed by same letter within the same column are not significantly different at 5 % Probability level according to LSD method.

5. SUMMARY AND CONCLUSIONS

First Experiment:

1. Different sources of nitrogen used exhibited different effects on the production for both cucumber cultivars.
2. There were no significant effects of adding different sources of nitrogen on plant height for both cultivars.
3. The effects of different nitrogen forms on vegetative growth of cucumber indicated that for the first cultivar the highest average number of leaf (69.5) was obtained from plants received (21.88 Kg N/du) from Ammonium sulfate, 20-20-20 and KNO_3 . This number was significantly different from plants received (21.79 Kg N/du) only from Ammonium sulfate, 20-20-20, KNO_3 and Urea.
4. For the second cultivar the highest average number of leaves (54.63) was obtained from plant received (21.88 Kg N/du) from Ammonium sulfate, 20-20-20 and KNO_3 . This number was significantly different from plants received (21.89 Kg N/du) from 20-20-20, KNO_3 and Urea only.
5. There were no significant effects of adding different sources of nitrogen on production for the first cultivar (Anas).
6. For the second cultivar the highest average production 5528 kg/du was obtained for plant received 21.9 kg N/du from 20-20-20, KNO_3 and Urea.

Second experiment:

1. Adding different levels of nitrogen on both marketable and total yield of cucumbers exhibited a significant quadratic effect.
2. A maximum total cucumber yield could be obtained by using 31.45 Kg N/du according to the statistical model obtained from the experiment.
3. The estimation of the maximum marketable yield for the quadratic model was obtained at (27.2 Kg N/du).
4. It is not economically to increase the amount of N over 26.5 Kg N/du.
5. There was a significant quadratic effect of adding different levels of nitrogen on both marketable and total fruit number of cucumber.
6. The estimation of the maximum marketable fruit numbers for the quadratic model was obtained at (27.5 Kg N/du).
7. For total fruit number the maximum production was obtained at (30 Kg N/du).
8. There was no significant difference on pH value among treatments at the three depths.
9. There was a significant difference in EC value among different nitrogen treatment.
10. The highest EC value was obtained with soil sample for treatment 3 (30.87 Kg N/du) which gave (6.39 dS/m).

11. The lowest EC was observed at the higher N treatment (62.30 Kg N/du).
12. The highest NO₃ content was obtained in fruit samples in both treatment 4 (46.58 Kg N/du) and 5 (62.30 Kg N/du).
13. The highest nitrogen percent in cucumber leaves was obtained from treatment 1 (0 Kg N/du), 2 (16.43 Kg N/du) and 3 (30.87 Kg N/du).
14. For both experiments, the soil analysis at the end of the experiment, showed no clear trend.
15. Sufficient fertilizers should be added to the plant as they needed to reduce the negative effect from using excessive fertilizers on plant, fruit quality and soil.
16. Soil should be analyzed at the beginning of the agriculture season before planting to avoid using more fertilizers that plant does not need it.
17. Soil chemical analyses are valuable for achieving efficient production of plants and solving problems of plant nutrient deficiencies.
18. Addition N fertilizer beyond the requirement usually does not increase crop yield, but will likely produce plant with undesirable characteristics and increase potential hazards to the environment.

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7. Appendices

Appendix A:

Rainfall quantity in Tulkarem station by month and station location, 1997,1998.

Month	Unit in mm	
	1998	1997
January	199.3	138.0
February	58.3	257.0
March	190.1	195.0
April	6.4	11.0
May	5.3	14.1
June	0.0	0.0
July	0.0	0.0
August	0.0	0.0
September	5.0	0.0
October	3.5	39.3
November	3.0	81.0
December	60.4	183.0
Total	531.3	918.4

Source: Department of Meteorology, Ministry of Transportation, Unpublished data.

Appendix B

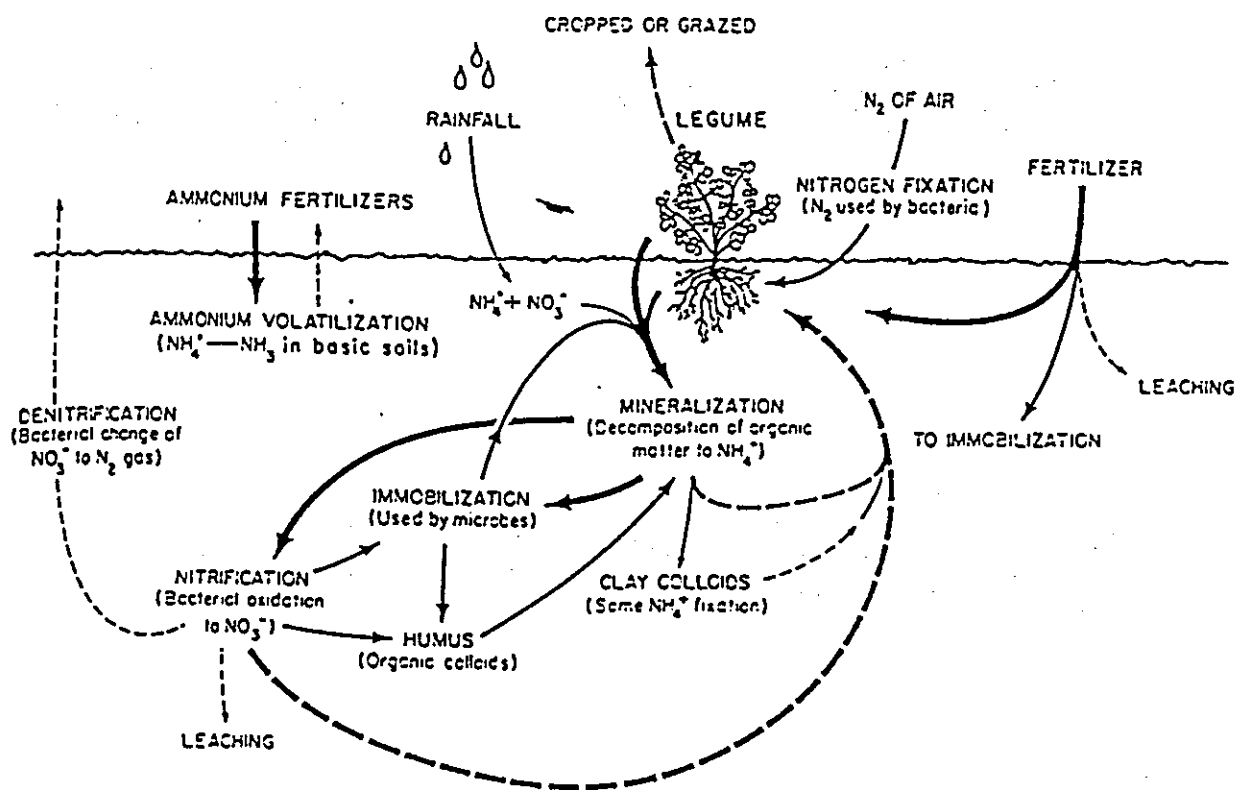
Mean Relative Humidity, Mean of Air Temperature, Mean of Minimum of Air Temperature, Mean of Maximum Air Temperature in Tulkarm Station by Month 1997, 1998

Month	Relative Humidity %		Mean of Air Temperature C		Mean of Minimum Air Temperature C		Mean of Maximum Air Temperature C	
	1997	1998	1997	1998	1997	1998	1997	1998
January	68	73	14.2	13.0	8.4	8.4	19.9	17.9
February	75	74	12.2	13.8	7.1	9.1	17.3	18.6
March	73	74	13.1	14.5	7.5	9.3	18.6	19.7
April	67	75	17.4	20.2	10.3	14.4	24.5	26.4
May	73	75	21.8	23.0	15.0	17.2	28.3	28.8
June	67	60	25.0	25.3	18.6	20.0	31.4	30.6
July	70	61	27.4	27.6	21.9	21.8	33.0	33.5
August	71	62	27.1	29.2	21.4	24.6	31.7	33.9
September	70	58	25.4	27.1	19.6	21.6	30.9	32.6
October	68	57	23.6	24.5	17.5	19.0	29.7	30.0
November	68	63	19.4	21.0	14.7	16.0	24.2	26.0
December	73	62	15.2	17.0	10.5	12.5	20.0	21.5
Annual Average	70	63	20.2	21.4	14.4	16.2	25.8	26.6

Source: Department of Meteorology, Ministry of Transportation, Unpublished data.

Appendix c

The nitrogen cycle, showing soil nitrogen changes, additions, and losses



The nitrogen cycle, showing soil nitrogen changes, additions, and losses. Losses are dashed lines; amount of change is indicated by relative line widths. (Courtesy Raymond W. Miller.)

Appendix D

Sources of the fertilizers N, P, K:

-Potassium (K) from the following sources:

- 1- Potassium nitrate (KNO_3) which contains 37% pure potassium.
- 2- 17-10-27: which contains 22.41 pure potassium.
- 3- 20-20-20: which contains 16.6% pure K.
- 4- Potassium sulfate: which contains 50% pure K.

- Nitrogen (N): from the following sources:

- 1- Potassium nitrates (KNO_3) which contains 13% pure nitrogen.
- 2- Ammonium sulfates ($(\text{NH}_4)_2\text{SO}_4$), which contains 21% pure nitrogen.
- 3- 20-20-20: which contains 20% pure nitrogen.
- 4- 17-10-27: which contains 17% pure nitrogen.
- 5- urea: which contains 46% pure nitrogen.

- Phosphorus (P) from phosphoric acid (H_3PO_4) which have:

1- specific gravity of $\text{H}_3\text{PO}_4 = 1.69 \text{ gm/ml}$

-Each 1ml H_3PO_4 contains: $1.69 \text{ gm/ml} * 0.85 \text{ gm } \text{H}_3\text{PO}_4$.

- So each ml of H_3PO_4 contains:

$1.69 \text{ gm/ml} * 0.65 \text{ gm } \text{H}_3\text{PO}_4 * 31/98 \text{ gm P} = 0.347 \text{ gm}$

2- from 20-20-20: which contains 8.60% pure P

3- from 17-10-27: which contains 4.30% pure P.

Appendix E
Analysis of Variance for Fruit Production in the First Cultivar
as Affected by Different N Source

ANOVA

WEIGHT_D

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14194.630	2	7097.315	.320	.729
Within Groups	465281.266	21	22156.251		
Total	479475.896	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: WEIGHT_D

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-25.6375	74.425	.734	-180.4125	129.1375
	3.00	33.7488	74.425	.655	-121.0263	188.5238
2.00	1.00	25.6375	74.425	.734	-129.1375	180.4125
	3.00	59.3863	74.425	.434	-95.3888	214.1613
3.00	1.00	-33.7488	74.425	.655	-188.5238	121.0263
	2.00	-59.3863	74.425	.434	-214.1613	95.3888

Appendix F
Analysis of Variance for Fruit Production in the Second cultivar
as Affected by Different N Source

ANOVA

WEIGHT_D

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1115880.37	2	557940.186	3.133	.064
Within Groups	3739213.68	21	178057.794		
Total	4855094.05	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: WEIGHT_D

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-460.6000*	210.984	.041	-899.3662	-21.8338
	3.00	-6.4400	210.984	.976	-445.2062	432.3262
2.00	1.00	460.6000*	210.984	.041	21.8338	899.3662
	3.00	454.1600*	210.984	.043	15.3938	892.9262
3.00	1.00	6.4400	210.984	.976	-432.3262	445.2062
	2.00	-454.1600*	210.984	.043	-892.9262	-15.3938

*. The mean difference is significant at the .05 level.

Appendix G
Analysis of Variance for Plant Hight for the First Cultivar
as Affected by Different N Source

ANOVA

AVL

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	114.396	2	57.198	.025	.975
Within Groups	47274.594	21	2251.171		
Total	47388.990	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: AVL

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-3.1875	23.723	.894	-52.5227	46.1477
	3.00	2.1250	23.723	.929	-47.2102	51.4602
2.00	1.00	3.1875	23.723	.894	-46.1477	52.5227
	3.00	5.3125	23.723	.825	-44.0227	54.6477
3.00	1.00	-2.1250	23.723	.929	-51.4602	47.2102
	2.00	-5.3125	23.723	.825	-54.6477	44.0227

Appendix II
Analysis of Variance for Plant Hight for the Second Cultivar
as Affected by Different N Source

ANOVA

AVL

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1170.750	2	585.375	.478	.627
Within Groups	25720.861	21	1224.803		
Total	26891.611	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: AVL

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	10.8750	17.499	.541	-25.5153	47.2653
	3.00	16.8750	17.499	.346	-19.5153	53.2653
2.00	1.00	-10.8750	17.499	.541	-47.2653	25.5153
	3.00	6.0000	17.499	.735	-30.3903	42.3903
3.00	1.00	-16.8750	17.499	.346	-53.2653	19.5153
	2.00	-6.0000	17.499	.735	-42.3903	30.3903

Appendix I
Analysis of Variance for Leaves Number for the First Cultivar
as Affected by Different N Source

ANOVA

AVLEA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	348.813	2	174.406	3.154	.063
Within Groups	1161.188	21	55.295		
Total	1510.000	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: AVLEA

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	6.8125	3.718	.081	-.9195	14.5445
	3.00	8.9375*	3.718	.026	1.2055	16.6695
2.00	1.00	-6.8125	3.718	.081	-14.5445	.9195
	3.00	2.1250	3.718	.574	-5.6070	9.8570
3.00	1.00	-8.9375*	3.718	.026	-16.6695	-1.2055
	2.00	-2.1250	3.718	.574	-9.8570	5.6070

*. The mean difference is significant at the .05 level.

Appendix J
Analysis of Variance for Leaves Number for the Second Cultivar
as Affected by Different N Source

ANOVA

AVLEA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	82.688	2	41.344	.457	.639
Within Groups	1898.719	21	90.415		
Total	1981.406	23			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: AVLEA

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	4.5000	4.754	.355	-5.3872	14.3872
	3.00	2.8125	4.754	.560	-7.0747	12.6997
2.00	1.00	-4.5000	4.754	.355	-14.3872	5.3872
	3.00	-1.6875	4.754	.726	-11.5747	8.1997
3.00	1.00	-2.8125	4.754	.560	-12.6997	7.0747
	2.00	1.6875	4.754	.726	-8.1997	11.5747

Appendix K

Regression Analysis for Total Production

Dependent variable.. **Total Weight** Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R : .01582

R Square .00025

Adjusted R Square -.04322

Standard Error 1751.85879

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	17679.0	17679.0
Residuals	23	70587212.0	3069009.2

F = .00576 Signif F = .9402

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	1.214929	16.007391	.015824	.076	.9402
(Constant)	7990.131250	610.546679		13.087	.0000

Dependent variable.. **TOTAL Weight** Method.. QUADRATI

listwise Deletion of Missing Data

Multiple R .50195

R Square .25195

Adjusted R Square .18395

Standard Error 1549.42454

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	17789130.4	8894565.2
Residuals	22	52815760.7	2400716.4

F = 3.70496 Signif F = .0410

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	129.683467	49.294630	1.689063	2.631	.0153
VAR00001**2	-2.058260	.756500	-1.746835	-2.721	.0125
(Constant)	6971.598091	657.067139		10.610	.0000

ANOVA

TOTAL_D

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		24467745.8	4	6116936.44	2.652	.063
	Linear Term	Contrast	17679.047	1	17679.047	.008	.931
		Deviation	24450066.7	3	8150022.24	3.533	.033
	Quadratic Term	Contrast	17771451.4	1	17771451.4	7.704	.012
		Deviation	6678615.35	2	3339307.68	1.448	.259
Within Groups			46137145.3	20	2306857.27		
Total			70604891.1	24			

Appendix M

Regression Analysis for Nonmarketable Production

Dependent variable.. Non Marketable weight Method.. LINEAR
 Listwise Deletion of Missing Data
 Multiple R .81113
 R Square .65794
 Adjusted R Square .64307
 Standard Error 296.17517

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	3880684.0	3880684.0
Residuals	23	2017553.9	87719.7
F =	44.23958	Signif F = .0000	

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
VAR00001	18.000129	2.706264	.811135	6.651	.0000
(Constant)	832.964000	103.221087		8.070	.0000

Dependent variable.. Non Marketable Weight Method.. QUADRATI

Listwise Deletion of Missing Data

Multiple R .81141
 R Square .65839
 Adjusted R Square .62733
 Standard Error 302.63358

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	3883322.1	1941661.1
Residuals	22	2014915.8	91587.1
F =	21.20016	Signif F = .0000	

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
VAR00001	16.434888	9.628226	.740601	1.707	.1019
VAR00001**2	.025078	.147760	.073636	.170	.8668
(Constant)	845.373648	128.338343		6.587	.0000

ANOVA

TOTAL_D

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		3914167.55	4	978541.888	9.864	.000
	Linear Term	Contrast	3880684.01	1	3880684.01	39.118	.000
		Deviation	33483.544	3	11161.181	.113	.952
		Contrast	2638.101	1	2638.101	.027	.872
	Quadratic Term	Deviation	30845.443	2	15422.721	.155	.857
		1984070.34	20	99203.517			
Within Groups			1984070.34	20	99203.517		
Total			5898237.89	24			

Appendix N

Regression Analysis for Total Fruit Number

Dependent variable.. Total Fruit Numbers Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R : .06477

R Square .00419

Adjusted R Square -.03910

Standard Error 23689.84876

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	54374986.5	54374986.5
Residuals	23	12907805485.7	561208934.2
F =	.09689	Signif F = .7584	

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	-67.378455	216.463041	-.064768	-.311	.7584
(Constant)	98639.317496	8256.235359		11.947	.0000

Dependent variable.. Total Fruit Numbers

Method.. QUADRATI

Listwise Deletion of Missing Data

Multiple R .49780

R Square .24780

Adjusted R Square .17942

Standard Error 21051.98362

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	3212088161.2	1606044080.6
Residuals	22	9750092311.0	443186014.1
F =	3.62386	Signif F = .0436	

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	1645.086427	669.764621	1.581351	2.456	.0224
VAR00001**2	-27.436269	10.278547	-1.718522	-2.669	.0140
(Constant)	85062.434885	8927.551052		9.528	.0000

ANOVA

TOTAL_D

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		5.154E+09	4	1.288E+09	3.300	.031
	Linear Term	Contrast	54374986.5	1	54374986.5	.139	.713
		Deviation	5.099E+09	3	1.700E+09	4.354	.016
	Quadratic Term	Contrast	3.158E+09	1	3.158E+09	8.088	.010
		Deviation	1.942E+09	2	970881048	2.487	.109
Within Groups			7.000E+09	20	390410511		
Total			1.296E+10	24			

Appendix O

Regression Analysis for Marketable Fruit Number

Dependent variable.. Marketable Number Of Fruit Method.. LINEAR
 Listwise Deletion of Missing Data
 Multiple R .19595
 R Square .03840
 Adjusted R Square -.00341
 Standard Error 23750.06911

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	518014956.5	518014956.5
Residuals	23	12973513001.0	564065782.7
F =	.91836	Signif F = .3479	

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
VAR00001	-207.966134	217.013297	-.195948	-.958	.3479
(Constant)	92774.469131	8277.222972		11.208	.0000

Dependent variable.. Marketable Number of Fruit Method.. QUADRATI

Listwise Deletion of Missing Data

Multiple R .53632
 R Square .28764
 Adjusted R Square .22288
 Standard Error 20901.15651

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	3880644399.1	1940322199.6
Residuals	22	9610883558.4	436858343.6
F =	4.44154	Signif F = .0240	

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
VAR00001	1559.189665	664.966087	1.469085	2.345	.0285
VAR00001**2	-28.312500	10.204906	-1.738268	-2.774	.0111
(Constant)	78763.982207	8863.589542		8.886	.0000

ANOVA

TOTAL_D

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		5.965E+09	4	1.491E+09	3.963	.016
	Linear Term	Contrast	518014957	1	518014957	1.376	.254
		Deviation	5.447E+09	3	1.816E+09	4.825	.011
	Quadratic Term	Contrast	3.363E+09	1	3.363E+09	8.935	.007
		Deviation	2.084E+09	2	1.042E+09	2.769	.087
Within Groups			7.527E+09	20	376332678		
Total			1.349E+10	24			

Appendix P

Regression Analysis for Nonmarketable Fruit Number

Dependent variable.. **Non Marketable Numbers** Method.. LINEAR

Listwise Deletion of Missing Data

Multiple R .85560

R Square .73204

Adjusted R Square .72039

Standard Error 1940.99975

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	1	236729064.9	236729064.9
Residuals	23	86652040.4	3767480.0
F =	62.83486	Signif F =	.0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	140.587678	17.735643	.855595	7.927	.0000
(Constant)	5864.848365	676.464882		8.670	.0000

Dependent variable.. **Non Marketable Numbers** Method... QUADRATI

Listwise Deletion of Missing Data

Multiple R .86140

R Square .74200

Adjusted R Square .71855

Standard Error 1947.39068

Analysis of Variance:

	DF	Sum of Squares	Mean Square
Regression	2	239949835.0	119974917.5
Residuals	22	83431270.2	3792330.5
F =	31.63620	Signif F =	.0000

----- Variables in the Equation -----

Variable	B	SE B	Beta	T	Sig T
VAR00001	85.896762	61.955842	.522755	1.386	.1795
VAR00001**2	.876231	.950806	.347480	.922	.3668
(Constant)	6298.452677	825.833330		7.627	.0000

ANOVA

TOTAL_D

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		243569287	4	60892321.8	15.259	.000
	Linear Term	Contrast	236729065	1	236729065	59.322	.000
		Deviation	6840222.48	3	2280074.16	.571	.640
		Quadratic Term	Contrast	3220770.19	1	3220770.19	.807
	Deviation	3619452.29	2	1809726.14	.453	.642	
Within Groups			79811818.0	20	3990590.90		
Total			323301105	24			

Appendix Q

Analysis of Variance for Fruit Nitrogen Contents as Affected by
Different N concentration

ANOVA

N

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.861	4	1.215	3.398	.017
Within Groups	15.021	42	.358		
Total	19.883	46			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: N

LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-.1012	.275	.714	-.6558	.4533
	3.00	-.1290	.284	.652	-.7015	.4435
	4.00	-.6860*	.267	.014	-1.2257	-.1463
	5.00	-.7450*	.267	.008	-1.2847	-.2053
2.00	1.00	.1012	.275	.714	-.4533	.6558
	3.00	-2.7778E-02	.291	.924	-.6142	.5587
	4.00	-.5848*	.275	.039	-1.1393	-3.0246E-02
	5.00	-.6438*	.275	.024	-1.1983	-8.9246E-02
3.00	1.00	.1290	.284	.652	-.4435	.7015
	2.00	2.778E-02	.291	.924	-.5587	.6142
	4.00	-.5570	.284	.056	-1.1295	1.548E-02
	5.00	-.6160*	.284	.036	-1.1885	-4.3518E-02
4.00	1.00	.6860*	.267	.014	.1463	1.2257
	2.00	.5848*	.275	.039	3.025E-02	1.1393
	3.00	.5570	.284	.056	-1.5402E-02	1.1295
	5.00	-5.9000E-02	.267	.826	-.5987	.4807
5.00	1.00	.7450*	.267	.008	.2053	1.2047
	2.00	.6438*	.275	.024	8.925E-02	1.1983
	3.00	.6160*	.284	.036	4.352E-02	1.1885
	4.00	5.900E-02	.267	.826	-.4807	.5987

*. The mean difference is significant at the .05 level.

Appendix R

Analysis of Variance for Leaves Nitrogen Contents as Affected by Different Nitrogen Concentration

ANOVA

N

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.957	4	2.989	10.416	.000
Within Groups	5.740	20	.287		
Total	17.697	24			

Post Hoc-Tests

Multiple Comparisons

Dependent Variable: N
LSD

(I) TREAT	(J) TREAT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-.1280	.339	.710	-.8347	.5787
	3.00	-3.2000E-02	.339	.926	-.7387	.6747
	4.00	1.3200*	.339	.001	.6133	2.0267
	5.00	1.3900*	.339	.001	.6833	2.0967
2.00	1.00	.1280	.339	.710	-.5787	.8347
	3.00	9.6000E-02	.339	.780	-.6107	.8027
	4.00	1.4480*	.339	.000	.7413	2.1547
	5.00	1.5180*	.339	.000	.8113	2.2247
3.00	1.00	3.2000E-02	.339	.926	-.6747	.7387
	2.00	-9.6000E-02	.339	.780	-.8027	.6107
	4.00	1.3520*	.339	.001	.6453	2.0587
	5.00	1.4220*	.339	.000	.7153	2.1287
4.00	1.00	-1.3200*	.339	.001	-2.0267	-.6133
	2.00	-1.4480*	.339	.000	-2.1547	-.7413
	3.00	-1.3520*	.339	.001	-2.0587	-.6453
	5.00	7.0000E-02	.339	.838	-.6367	.7767
5.00	1.00	-1.3900*	.339	.001	-2.0967	-.6833
	2.00	-1.5180*	.339	.000	-2.2247	-.8113
	3.00	-1.4220*	.339	.000	-2.1287	-.7153
	4.00	-7.0000E-02	.339	.838	-.7767	.6367

*. The mean difference is significant at the .05 level.

8. الملخص بالعربية

اثر مستوى ومصدر النيتروجين على نمو وانتاج وجودة محصول
الخيار تحت ظروف الزراعة المحمية

إعداد

علياء عثمان فهمي قناديلو

اشراف

د. نعمان مزيد

د. حسان ابو قاعود

تم في موسم ٢٠٠٠/١٩٩٩ إجراء تجربة لدراسة تأثير أسمدة مختلفة من النيتروجين وكذلك مستويات متباينة من السماد نفسه على نمو وإنتاجية الخيار تحت ظروف الزراعة المحمية. أجريت التجربة في كلية الزراعة - جامعة النجاح الوطنية - طولكرم. اشتمل البحث على تجربتين: الأولى: أنواع أسمدة نيتروجينية (Ammonium sulfate, 20-20-20, KNO₃, Urea) والثانية تراكيز مختلفة من النيتروجين (16.43, 30.87, 46.58, 62.30 Kg/dunum). استخدم صنفين (أنس و سوبر) في التجربة الأولى وصنف IV36 في التجربة

الثانية. وجد في تجربة نوعية السماد أن إنتاج الخيار بالنسبة للصنف الأول (انس) لم يتأثر معنوياً بالمعاملات بخلاف الصنف الثاني (سوبر) حيث وجد اختلاف معنوي بين المعاملات. حيث دلت النتائج التي تم الحصول عليها أن أعلى إنتاج لمحصول الخيار (٥٥٢٨,١٥ كغم/دونم) قد تحقق عند استخدام المعاملة رقم ٢ (KNO_3 , Urea, 20-20-20). بالنسبة لطول النباتات لم يوجد أي فرق معنوي للصنفين. أما بخصوص عدد الأوراق ففي جميع الأسمدة المستعملة كان هناك فروقات معنوية للصنف الأول حيث وجد أن متوسط عدد الأوراق قد بلغ (٦٩,٥) عند استخدام المعاملة رقم ١ ($Ammonium\ sulfate, 20-20-20, KNO_3$) , بينما لم يلاحظ هذا الفرق بالنسبة للصنف الثاني .

النتائج التي تم الحصول عليها من هذه الدراسة أظهرت أن أعلى إنتاج كلي لمحصول الخيار (٩٧٢١ كغم/دونم) قد تحقق عند إضافة ٣٠,٨٧ كغم نيتروجين صافي للدونم، بينما وجد أن أقصى إنتاج للمحصول المسوق من الخيار قد حصل عند إضافة ٢٧,٢ كغم من السماد النيتروجيني الصافي للدونم وقد كان الإنتاج يساوي ٧٦٦٥ كغم . عند إجراء التحليل الاقتصادي للربح الصافي الذي يمكن أن يحصل عليه المزارع وجد أن أعلى ربح حسب الأسعار المحلية للخيار والسماد يكون عند إضافة ٢٢,٣٤ كغم سماد نيتروجيني صافي للدونم وذلك بناء على العلاقة التربيعية المعنوية , كما وجد أن هناك فروقات معنوية بالنسبة للإنتاج

الكلي والإنتاج المسوق والعدد الكلي والعدد المسوق ما بين المعاملات . عند تحليل النيتروجين المتبقي في الثمار والأوراق لوحظ ارتفاع كبير في نسبة النيتروجين المتبقي في الأوراق وذلك عند استخدام المعاملة الثانية (١٦,٣٤ كغم نيتروجين صافي للدونم)، بينما لوحظ في الثمار ارتفاع كبير في تركيز النيتروجين عند استخدام المعاملة الخامسة (٦٢,٣٠ كغم نيتروجين صافي للدونم)، بخصوص محتوى الثمار من النترجين فقد وجد اختلافات معنوية بين التراكيز المختلفة .